

# Exhibit A

**UNITED STATES DISTRICT COURT  
DISTRICT OF MASSACHUSETTS**

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CHARU DESAI,

Plaintiff,

v.

UMASS MEMORIAL MEDICAL  
CENTER, INC.; UMASS MEMORIAL  
MEDICAL GROUP; UNIVERSITY OF  
MASSACHUSETTS MEDICAL SCHOOL,  
UMASS MEMORIAL MARLBOROUGH  
HOSPITAL, MAX ROSEN, M.D.,  
DARREN BRENNAN, M.D.,  
STEPHEN TOSI, M.D.,  
AND KARIN DILL, M.D.,

Defendants.

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CIVIL ACTION NO.:  
**4:19-CV-10520-DHH**

**PLAINTIFF CHARU DESAI'S EXPERT WITNESS DISCLOSURE**

The Plaintiff, Charu Desai, M.D., by and through her attorneys, discloses the witness listed below may be called at trial to offer expert testimony.

I. *Disclosure – Pogos G. Voskanian, M.D.*

Plaintiff expects to call Pogos G. Voskanian, M.D., of Drexel University College of Medicine to offer expert opinion testimony. Dr. Voskanian is a board certified forensic psychiatrist. He earned a Bachelor of Sciences in Engineering in 1974 from Yerevan Polytechnic Institute in Yerevan, Armenia; and in 1986 completed a pre-med program at Harvard University Extension in Cambridge, Massachusetts. He earned his M.D. degree in 1992 at the University of Massachusetts Medical School in Worcester, Massachusetts. He completed his psychiatry residency in 1996 at Tulane University Medical Center in New Orleans, Louisiana; and a further forensic psychiatry fellowship in 1997, also at Tulane University Medical Center.

Dr. Voskanian has worked in private practice as psychiatrist for over 20 years since his fellowship. In addition, Dr. Voskanian has conducted forensic psychiatric evaluations, and formulated over 1,000 expert opinions in State and Federal Courts, for Governmental Agencies including the US Department of State, and for insurance companies. Dr. Voskanian is academically affiliated with Drexel University College of Medicine (MCP Hahnemann University) where he is an Associate Clinical Professor of Psychiatry and the Director of the Psychiatry and Law Program. Included among his many professional qualifications are Diplomate of American Board of Psychiatry and Neurology in the specialty of Psychiatry; Diplomate of American Board of Psychiatry and Neurology in the sub-specialty of Forensic Psychiatry; Diplomate of National Board of Medical Examiners; he is licensed to practice medicine in Pennsylvania, New Jersey, California, Virginia, and Louisiana; and he is a member of the American Medical Association, the American Psychiatric Association, the American Academy of Psychiatry and Law, the Pennsylvania Psychiatric Association, the Philadelphia Psychiatric Society, the Armenian Medical Association of Philadelphia, and the American Academy of Forensic Sciences.

Dr. Voskanian's report includes a complete statement of all opinions to be expressed and the basis and reasons therefore, the information considered in forming the opinions, and any exhibits to be used as a summary of or support for the opinions; a copy of his curriculum vitae, which details Dr. Voskanian's qualifications; a listing of all publications Dr. Voskanian authored within the preceding ten (10) years; and a listing of other cases Dr. Voskanian has testified at trial or by deposition in the preceding four (4) years. In this case, Dr. Voskanian is being compensated at a rate of \$360.00 per hour for his study and testimony.

Plaintiff expects that Dr. Voskanian will offer testimony regarding his assessment of the emotional distress that Dr. Desai suffered and is likely to suffer moving forward as a result of her termination from her employment at the UMass Memorial Medical Center after about 30 years.

II. *Reservation of the Right to Rebut and Comment*

Plaintiff reserves the right to supplement and amend this disclosure as discovery is ongoing. Plaintiff reserves the right to have her expert critique, comment upon and rebut the testimony and opinions of the Defendant's experts, if any. Plaintiff further reserves the right to call as an expert witness any person disclosed by the Defendant as an expert witness. Plaintiff reserves the right to elicit from such witness testimony on any of the issues in this case without specifically adopting the testimony and opinions of the Defendant or the Defendant's experts.



Respectfully Submitted,

CHARU DESAI,  
By her attorneys,

/s/ Patricia A. Washienko  
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211 Congress Street, Suite 720  
Boston, MA 02110  
p: 617.723.0008 f: 617.723.0009

Dated: August 1, 2021

**CERTIFICATE OF SERVICE**

I, Brendan T. Sweeney, hereby certify that a true and accurate copy of the foregoing document was served upon attorneys for the Defendants herein, by electronic mail.

/s/ Brendan T. Sweeney  
Brendan T. Sweeney

Dated: August 1, 2021

# Exhibit B



DIPLOMATE OF AMERICAN BOARD OF PSYCHIATRY AND NEUROLOGY IN  
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7/28/2021

Brendan T. Sweeney, Esq.  
Freiberger & Washienko, LLC  
211 Congress Street, Suite 720  
Boston, MA 02110

RE: Charu Desai

Dear Mr. Sweeney,

As per your request, I interviewed your client, Dr. Charu Desai, via Zoom on July 24, 2021, for approximately 5 hours. The purpose of the evaluation was to assess the emotional distress your client has suffered and is likely to suffer moving forward as a result of her termination from her employment at the UMass Memorial Medical Center after about 30 years. In addition to the interview of Dr. Desai, I reviewed the following documents:

- Amended Complaint
- The notice of termination of Dr. Desai
- Dr. Desai's answers to interrogatories
- Dr. Marc Cutler's notes and a letter he wrote in support of Dr. Desai
- Deposition transcript of Dr. Cutler
- Deposition transcript of Dr. Desai
- Letters of Support and Affidavits from:
  - Letter from Dr. Charu Desai's daughter, Diana Desai, MD, MBA, dated 7/23/2021 and Affidavit, dated 7/26/2021
  - Letter from Dr. Charu Desai's husband, Shirish Desai, MD, dated 7/23/2021 and Affidavit, dated 7/26/21
- Letters of Recommendation, including from (and attached to this report):
  - Jerry P. Balikian, MD, FACR, Professor of Thoracic Radiology, Interim Director of Thoracic Radiology, UMass Memorial Health Care, two letters, dated 5/14/2001 and 9/20/2015
  - Daniel Berman, MD, Department of Radiology, UMass Medical Center
  - William J. Blake, MD, radiologist, Holden District Hospital, dated 5/17/2001
  - Andrew Chen, MD, Assistant Professor of Neuroradiology, UMass, dated 4/3/2018
  - Robert D. Chiulli, MD, Chief of Radiology, Worcester City Hospital, dated 10/15/1991
  - A. Alan Conlan, MD, Professor and Chairman, Professor of Thoracic Surgery, UMass, dated 5/14/2001

- Carl D'Orsi, MD, FACR, Professor and Vice Chairman, Directory, Diagnostic Radiology, UMass, dated 1/7/2002
- George H. Eypper, MD, General Internal Medicine/Adult Primary Care, UMass, dated 4/24/2018
- Karl Fabian L. Uy, MD, FCCP, FACS, Associate Professor and Chief, Division of Thoracic Surgery, UMass Memorial Health Care, UMass Medical School, dated 3/11/2020
- Joseph T. Ferrucci, MD, Professor of Radiology Emeritus, UMass Medical School, dated 3/22/2018
- Gopal R. Vijayaraghavan, MD, Associate Professor of Radiology, Director, Breast Imaging, dated 4/5/2018
- Aaron Harman, MD, Assistant Professor, Department of Radiology, UMass Memorial Medical Center, UMass Medical School, dated 3/25/2018
- Richard S. Irwin, M.D., Professor of Medicine, Director, Division of Pulmonary, Allergy and Critical Care Medicine, UMass Medical School, 2 letters, dated 12/24/2001 and 3/29/2018
- Sanjay Kamath, M.D., Department of Radiology, UMass Memorial, dated 5/25/2001
- David Kydd, MD, Chief Resident, Department of Radiology, FRCPC Neuropathology, dated 5/11/2001
- Jeffrey Leppo, MD, Interim Chair, Department of Radiology, Division of Nuclear Medicine, Department of Medicine, Division of Cardiology, UMass Medical School, dated 11/30/2001
- Lacey McIntosh, DO, MPH, Assistant Professor, Director of Oncologic Imaging, Body, Chest, and PET/CT Divisions, Department of Radiology UMass Medical Group, dated 5/15/2018
- Paul A. Ricciardi, MD, Associate Professor of Medicine, Division of Hematology/Oncology, UMass Memorial Medical Center, dated 4/30/2001
- Ricardo Rosales, MD, Diagnostic Radiologist, Framingham, Ma, dated 10/5/1991
- David A. Rosenfield, MD, Wachusett Family Practice, Holden, Ma, dated 5/8/2001
- Edward Smith, MD, Professor and Chairman, Department of Radiology, UMass Memorial, UMass Medical School, dated 7/15/2001
- Cynthia Umali-Torres, MD, Residency Program Director, UMass Memorial Medical Center, dated 1/16/2002
- Francis A. White, MD, Radiology Clinic Inc. Worcester, Ma, dated 10/30/1991
- Simon E. Writter, MD, Southbridge Ob-Gyn associates, dated 11/13/1991
- Joseph Makris, MD, Physician, University of Massachusetts, dated 7/27/21

### **Statement of Non-Confidentiality**

Immediately prior to the interview of Dr. Charu Desai, I informed her as to the nature and purpose of the present evaluation. It was explained to Dr. Desai that the current interview was not conducted in the context of a doctor-patient relationship, but as an independent medical evaluation at the request of her attorney, Brendan Sweeney, Esq., and that testimony may be required. Dr. Desai understood that the evaluation was not confidential. She understood that a report would be prepared and submitted to the requesting party, and that the interview was not conducted in the context of a doctor-patient relationship. Dr. Charu Desai voiced her understanding and agreed to proceed.

## REVIEW OF COLLATERAL INFORMATION

### Precipitating factors leading to the current evaluation:

According to Amended Complaint, "For over twenty-six years, Dr. Charu Desai worked at and for the UMass Memorial Medical Center, Inc., the UMass Memorial Medical Group, the University of Massachusetts Medical School, and UMass Memorial Marlborough Hospital. She was an extremely highly-regarded radiologist, respected by students, trainees, department colleagues and physicians across those institutions. Beginning in approximately 2016, however, she was subjected to disparate treatment compared to her white, male, younger, U.S.-born and non-disabled colleagues who performed the same or substantially similar work. Then, in 2018, she was falsely accused of performance deficiencies, terminated, and will be replaced by a white, younger, U.S.-born and non-disabled radiologist with less experience...

As a result of this treatment, Dr. Desai brings this action for damages against the UMass Memorial Medical Center, Inc., the UMass Memorial Medical Group, the University of Massachusetts Medical School, UMass Memorial Marlborough Hospital, Dr. Max Rosen, Dr. Darren Brennan, Dr. Stephen Tosi, and Dr. Karin Dill for unlawful employment discrimination against her on the basis of age, race, national origin, gender/sex and/or disability, and/or for aiding and abetting discrimination, all in violation of Title VII of the Civil Rights Act of 1964, 42 U.S.C. § 2000e-1(k); the Americans with Disabilities Act, 42 U.S.C. § 12132, the Age Discrimination in Employment Act, 29 U.S.C. § 216(b), the Massachusetts Fair Employment Practices Law, M.G.L. c. 151B, § 4 and/or the Massachusetts Equal Pay Act, M.G.L. c. 149, § 105A. She also brings claims against them for breach of her employment contract and defamation. Finally, she brings claims against Drs. Rosen, Brennan, Tosi, and Dill for tortious interference with advantageous relations and defamation."

### Review of Dr. Cutler's depositions and notes

Dr. Cutler during his deposition summarized his treatment provided to Dr. Desai, "Individual psychotherapy and pharmacotherapy to help her mourn the loss of her career and restore her dignity that she had worked as a radiologist for many years and that you can't take away the successes that she had had, her training, and what she had maintained, her raising three children, the success of her children, her... her maintaining a marriage since 1970..." "... I basically do a lot of cognitive behavioral therapy where I get to her look at things in a different way."

Dr. Cutler described, "You know, initially, she's just worthless. She -- she was just -- you know, has no dignity, no accomplishments, and you know, that's not the reality as she presented her history. She had to overcome a lot of things in -- in her life at the time. Given her age, at least in the United States, there's a lot of discrimination against females, and during the training, there's discrimination against females. She's also from India. There's discrimination against, you know, people from -- foreign medical graduates. She went to a foreign Indian medical school, and she overcame all of those things and passed her boards and was able to function as a radiologist for many years..."

She is preoccupied with the case, all sorts of depositions. She continues to focus on that a grave injustice was done to her by some new department chairman of the Department of Radiology. She continues to have some difficulty with concentrating, although the duloxetine has -- you know, has helped maintain her. She continues to -- to have some difficulties with her general overall functioning."

Dr. Cutler diagnosed Dr. Desai with Major Depressive Disorder. He discussed some of the symptoms, "The decreased concentration, a subjective sense of depression, lack of energy, chronic tearfulness. She has no libido... She's not suicidal."

Dr. Cutler used Cymbalta 60 mg for treatment of Dr. Desai's depression.

Dr. Cutler discussed some of the precipitating stressors of Dr. Desai's condition, "a number of episodes that she was criticized, not accommodated..."

Dr. Cutler noted that Dr. Desai "doesn't have a biological strong component toward depression, as evidenced by past history, recurrent depressions, or a family history."

Dr. Cutler testified, "She -- she was called in and wasn't asked, gee, what are your plans in the future, you know, are you thinking of retirement because you're whatever age she is. She was just, you know, told that she was summarily dismissed."

Dr. Cutler testified, "The fact that I did not believe she had a biological etiology of her depression, which is why I put that she had no past history of a psychiatric disorder and no family history of a psychiatric disorder." He confirmed that Dr. Desai "specifically attributed her current difficulties or symptoms that she was experiencing with a series of events in the workplace." Dr. Desai characterized to Dr. Cutler, that she was "denigrated, demeaned, that here she had been trained at UMass. and that she was summarily dismissed..." He clarified, "Like I say, as a treating psychiatrist, I don't want to spend 45 minutes every week going over how horrible things are so she stays stuck. I'm trying to treat her, and that's why a treating psychiatrist is different than someone just going in for an expert opinion."

Dr. Cutler was asked to read his notes. He started seeing Dr. Desai on 5/28/20. He read his note, "Question anxiety, tearful and anxious, appetite down, no weight loss, decreased concentration, inergia, decreased libido, no suicidal ideation, no alcohol. 3/19 is when it started. Past history, none. Past medical history, primary care physician, George Eypper, MD. No allergies to any medication. Hypothyroidism. Takes Synthroid 75 micrograms a day since 2004. No headaches. No dizziness. No problems with her GI tract. Family history, father died in 2007 at the age of 79. No family history of any psychiatric problems. Good relationship. Mother died in 2017 at the age of 82. She was a teacher. No psychiatric, no substance abuse disorders. Brother died in 2005. He had mild cerebral palsy, he died at the age of 63. He had no medical problems. Brother, 58, lives in New York, has no psychiatric or substance abuse disorder. Has a best friend. Left Mumbai in 1974. Practice Hinduism. Social history, radiologist 1982, training 1/92 to 3/19, was in UMass. Mumbai. Graduated from a medical school there in 1973. "Husband is 75, was an internist, retired in March of 2019. They married in 1970. Daughter, Aseshis (phonetic) is age 42, single, no psychiatric or substance abuse disorder. Son, Kristaki (phonetic) is age 37, has an MBA, and has— is married with one child. Her daughter, Dianna, is age 35, is a medical doctor, a clinical pathologist..."

Mental status exam, oriented to time, person, and place. Memory grossly intact. Affect and mood depressed. No looseness of associations. No hallucinations. No suicidal ideation. Diagnosis, major depressive disorder... and she told me at that time that she had an attorney. We started her on Cymbalta, duloxetine, 60 milligrams. The telephone number to call in the pharmacy. On 6/7, talked to -- again, patient talked to via telephone according to the coronavirus pandemic. Still having decreased sleep. Has started the Cymbalta. No special side effects, and she talked about work, last working on 3/17/2019."

Note of June 10th, 2020, "I, again, talked to -- my office to her home according to coronavirus pandemic protocol. Addressing issues of -- of what COVID-19, you know, means to her, and at that time, she was sleeping somewhat better."

Note of June 17th, 2020, "Patient, again, talked to via telephone from my office to her home according to the coronavirus pandemic protocol, and addressing issues, some of her life, trying to find out about what depression means to her and what -- anybody in the family having depression.

Note of June 24, 2020, "again, talking to -- and I'm trying to find out about whether there's any self-medication that she's ever had, any -- any addictions or -- or those kinds of things."

"...7/14, again, talked to that, and we're -- we're talking about her ability to -- to self-care, whether there's any problems with her self-care, which she said there was not... 7/21, again, we're talking about her fear of getting coronavirus, what she's doing to be safe, something that I addressed with almost every patient that I have. And then 7/29, again, family members back in India that were getting coronavirus, and then at 8/19, we were talking about her need for help, the family support, the daughter, especially the younger daughter that's a clinical pathologist that -- that encouraged her to -- to see someone in -- in her area via telephone and -- and what -- what that meant... Well, she was staying safe, and in India -- I may have mentioned it more in some other sessions, at least I remember we had some -- there were several deaths in her family in -- back in India. There were -- there were a number of people, brother-in-laws, and you know, there were always people that were getting sick with it in the summer and into the fall, and -- and she was, you know, basically staying safe, not going out. She used to be involved with her Hindu temple, but she wasn't doing anything and basically was not going out." Regarding grieving, "...no more than anyone would be that had lost some relatives that she didn't see regularly because they're back in India, but I think, you know, she was appropriately mourning some of their deaths."

Dr. Cutler continued to read his subsequent notes, "So, in this session, we're -- basically, we're talking about addressing issues of the memories of -- of her unfavorable treatment at UMass., that she perceived that she -- she was treated as far as coverage differently, wasn't allowed to hire someone. She talked about that --that she -- she was accused of incompetency."

Note of 9/15/20, "Patient talked to via telephone from my office to her home according to the coronavirus pandemic protocol addressing issue of memory of unfavorable period at UMass...

9/29, again, talked that there -- there was some -- she was going to have to -- she was anxious about a -- a deposition that was coming out where she had to go into Boston. Her -- her daughter who lives in Staten Island was giving her a lot of support. She was having a lot of -- a lot of difficulty, and I was encouraging her because I don't know whether she was taking her medication or not, that to make use of the duoxetine, and we talked about how important that was...

October 6th, telephone from my office to her home and addressing her preoccupation with the case. And when I say, 'the case,' it's everything from -- you know, that's going on with any legalities or whatever interaction with her attorney, you know, with her going to meet to do -- you know, do anything via that and if it's an ongoing case and those things."

Dr. Cutler described Dr. Desai's preoccupation with her case, "Well, it was all-consuming. That -- that's basically what her -- her life is. You know, if told she was retired, she wasn't enjoying her retirement. She -- she now had a full-time job thinking about the case."

Dr. Cutler continued, "So these were some sessions where specifically it was addressed her sister-in-law had died in India from COVID-19 and helping her, you know, get through that and, you know, what -- what had been going on with that. That was 8/4 and 8/11...

And then, on 10/29, it's this deposition that she, again, is preoccupied with, as she should. She's nervous about being asked questions and, you know, how she -- whether she's going to have a anxiety attack or, you know, those kinds of things, and I gave her, you know, support and, also, you know, pointing out to her that that's part of the case...

Patient talked to by telephone my office to her -- her home according to coronavirus, addressed the issue of the deposition...

Again, that's a cue for me to remember all -- all the things that were going on with the deposition, her concern, her -- you know, her anger about needing to have to be deposed or her anxiety about what questions, you know, might be asked...

We did not meet that next week. We didn't meet again until 11/12...

It wasn't canceled. We were meeting every other week, and I -- I think I had thought that, maybe, we should meet, and then it never -- it never happened. I told her she could call me. I think she had -- had already had the deposition and, if she needed to call me for -- you know, to process things, that she could."

On 11/12/2020, "Patient talked to via telephone from my office to home according to coronavirus pandemic... and again, about the deposition and -- and her feelings towards the deposition and how -- how she had gone and how difficult it was for her. Her husband had -- had driven her. She was concerned -- she told me that -- that she had some irregular heart rhythms or something like that..."

Dr. Cutler continued to read his notes, "So one -- again, her -- again, going over the history of how she felt that she was mistreated at UMass., giving me the history that it -- she had thought, I mean, when is she going to retire. I mean, she -- she's of the age, and -- and she wished that whoever she spoke to -- I guess, the chairman -- you know, had -- had asked her what her retirement plans are, and she might have said that she wouldn't mind, you know, either working part-time or gradually transitioning into retirement, but that wasn't the -- the way the question got. That's what that session was taking about."

When asked, "Do you recall when -- when Dr. Desai expressed to you she -- she planned on retiring?" Dr. Cutler replied, "She didn't have an exact date, but she had, certainly, some -- some thoughts that she's getting older and her husband had retired. We talked about what it meant that -- that he had retired already and what that meant about her continuing working..."

On 12/15, "Let's see. I'm talking more about the medication and, you know, whether it's helping her or not, whether she has any, you know, side effects from it, which she didn't, ongoing case against UMass., issue of no waiting, any results from, I guess, her deposition, how she had done or whether the -- how



the case was proceeding. I think she, maybe, was awaiting some sort of communication from her attorney...

And then she's still, you know, very much talking about the case, and then she, also, had a visit from her daughter from Staten Island."

Dr. Cutler did not meet with Dr. Desai from December 29, 2020 to March 2, 2021.

"March 16th, again, the issue of her case against UMass. and then, also, that she's going to be getting vaccinated for, you know, COVID-19 and, again, something that I do with a number of patients at that point in time, you know, restrictions in her life regarding COVID-19 was additive. Whatever other psychiatric problems any of my patients have had, that COVID-19 is in the background, too, and what that means...

3/30, again, talking about the issue of the continued case and that she feels like she's in a battle, to use that word, and I'm -- and I'm trying to get her to -- you know, to look at the quantum of her responsibility, that she has a choice of having the case or not having the case...

It's ongoing that -- that she feels like she's in a battle. I mean, my understanding is that she's -- she's in a fight...

4/13, again, we talked about medication. She -- she needed some more medication; so I would be calling in the telephone number at the pharmacy, and -- and, again, the number of relatives that have died from COVID-19."

In another note, dated 3/30, "I remembered some more things about her legal case against UMass. and -- and her portrayal, and I have down there, (as read) "Their passive-aggressiveness in non-responding to a deposition," and she shared with me that, I guess, her lawyer either subpoenaed the -- the chairman and -- and she, you know, said that he at least at that point had not responded to it. So I -- I wanted to remember that specific fact, and that's -- so that's, probably, why that's there twice."

On 4/20, "... Again, more talking about the case and her feeling about the passive-aggressive stance of UMass. in her case, that, you know, she did not feel like they were playing fairly."

Dr. Cutler testified, "She had had some sort of medical episode that she thinks could have called into question whether she, you know, could do all that she needed to do, including coverage and things like that, and again, she portrayed to me that, if she wasn't allowed to pay for someone, which she was willing to do, to cover for her, that wouldn't have been an issue." Dr. Cutler didn't know what the issue was, "No. No, I don't. I mean, it could have been a panic attack because many people go to the emergency rooms with chest pain and with cardiac things and, after the full work-up, they find nothing, but it was some sort of cardiovascular something, and -- but I -- you know, I did not pursue it, and my thinking was, well, this very well could have been a -- a panic attack."

Dr. Cutler testified, "She and I have had as part of her therapy my supporting her and my experience since we're in somewhere the similar age range, femaleness, non-foreign, in other words, non-American, non-native speaking English, it's something to overcome, and again, in trying to be supportive of her, I have many times said, Well, look at all you've overcome, and you know, again, don't look at this

as a defeat, if you would, quote, lose the battle; so, in that sense, yes, I mean, you know, the fact that she was a foreigner.”

Dr. Cutler was asked, “Assuming the case would not disappear, what do you believe her future treatment would be, at least for the duration that it continues; similar courses she's on now, you know, periodic sessions with you and continuation of the medication? Is that what you expect in the near future?” He replied, “I expect that, if there was any increase in symptoms, we actually would think of medication augmentation, medication change, a more frequent -- even though I don't have -- you know, again, I -- I do a lot of group psychotherapy by Zoom. You know, I think of putting -- you know, augmenting that kind of psychotherapy. You know, that's what I would expect.” (if her condition and symptoms worsened in the future.)

Dr. Cutler was asked, “... you wrote and Mr. Wakefield asked you some questions about the -- the paragraph that says, ‘Consequently, I can state that her current psychiatric disorder and need for treatment is caused by a series of events in the workplace.’ Do you see that?” Dr. Cutler replied, “Yes.”

Dr. Cutler was asked, “Did she at any point -- well, did she prior to August 18, 2020, mention that there were non-COVID stressors in her life?” He replied, “Not that I recollect.”

#### **Letters from Dr. Charu Desai's husband and daughter**

##### Letter from Dr. Charu Desai's husband, Shirish Desai, MD

“I have been married to my wife, Charu Shirish Desai, for over 50 years. She has experienced significant deterioration of her mental health since Dr. Rosen fired her at UMASS Medical Center. Prior to this traumatic event, I would describe Charu as a person that was full of life. She felt deeply fulfilled at work and enjoyed her personal time with family and friends. She regularly participated in recreational activities. Now, she has difficulty doing basic things that she was able to do before. She no longer drives, so I drive her everywhere if she needs to do something essential. But she prefers to spend most of her time at home. I would describe her general personality right now as lethargic, lacking enthusiasm and energy. She often forgets things. She cries a lot. She cannot seem to get over what happened to her at UMASS and has told me that life is not worth living if this is what she has to experience. Lately, she appears more overwhelmed by and preoccupied with the lawsuit than ever before. She keeps saying that the whole situation with UMASS was ‘premeditated murder.’ I can only hope that she will recover in the near future. I am worried that with her current state right now that she may never recover from this trauma. I pray this is not true.

Since this all happened to my wife, I quit working. I felt that I needed to support Charu full time due to the extent of the grief that she was experiencing as a result of UMASS' actions.

To cheer us up with everything going on, my daughter held a surprise ‘retirement party’ for my wife and me, even though she knew that Charu was terminated and that I had to stop working in order to help my wife. She thought that if she could find a way to show Charu how many people adored and respected her, then my wife could get over the pain associated with her firing. She also thought it would cheer me up too because I did not want to stop working. I actually retired in 2002 but have been doing contract work since then at the same hospital. Charu and I had no plans to stop had this situation with UMASS not come about. Unfortunately, these ‘cheer up’ mechanisms did not help my wife.

Last year, I forced her to see a psychiatrist because I felt that the situation became too difficult to handle without seeking professional help. I even set up the appointment for her. She sees a psychiatrist regularly. But I personally don't think that these sessions are making her better, especially with what I have seen lately."

Letter from Dr. Charu Desai's daughter, Diana Desai, MD

"I write this letter, with a heavy heart, on behalf of my mother, Charu Desai, MD. In addition to being a wonderful mother, she had an amazing professional career as a radiologist at UMASS Medical Center. She was well respected by previous chairs and colleagues, including, but not limited to, Drs. Smith, Ferrucci, Balikian, and the late Dr. Umali to name a few. She dedicated her entire life to UMASS, and was wrongfully terminated by Dr. Rosen, the Chair of Radiology at UMASS. Prior to her unlawful termination, she was an extremely pleasant, happy, and optimistic person. She was full of life and was always smiling. She thoroughly enjoyed her work, excelled at her craft, and was thankful to be able to save countless lives and help patients in need. Following Dr. Rosen's despicable treatment of my mother, she has not been the same person and has since been diagnosed with severe depression. I have tried to be there for her every step of the way. I personally set her up with a therapist, who she had a few sessions with. With COVID restrictions in place, I found it harder to be there for her. My dad has stopped working since my mom left employment so that he could completely dedicate himself to being there for my mom full time, however he noticed that her symptoms were getting significantly worse than he could handle. As a physician himself, he felt that it was in his wife's best interest to seek professional psychiatric help. I felt similarly. Therefore, my father reached out to Dr. Cutler, a local psychiatrist, in order to set up an appointment on her behalf. She has been in therapy ever since. My mom initially wanted avoid seeing a psychiatrist at all costs because of the stigma and humiliation associated with mental illness. She thought she would be able to get through the trauma associated with her termination by having familial support. Although my dad and I initially thought that we would be able to support my mom emotionally in order to help her overcome the devastation associated with her termination, we noticed a continued decline in her mental health. We no longer felt it appropriate to manage the situation on our own, especially with COVID limiting direct personal interactions. We felt that there was no choice except to force her to get professional psychiatric help, as it was in her best interest. Of note, my mother never had any psychiatric issues in the past. At present, she continues to experience intense distress and anxiety, and is consumed by the litigation with UMASS. She cannot think about anything else. More recently, I have noticed days where she sobs inconsolably and has difficulty getting out of bed. She used to be able to do an active job search, but given her recent emotional state, those efforts have been temporarily halted."

**Letters of recommendation** (attached to this report)

Multiple letters of recommendation from Dr. Charu Desai's colleagues and supervisors attest to her extraordinary ethical, professional, and humane qualities. These are too voluminous to integrate into this report (please see attached).

**SUMMARY OF INTERVIEW WITH DR. CHARU DESAI**

Dr. Charu Desai is a 70-year-old woman, born to an intact family unit in Mumbai, India. Dr. Desai's father, Dinkarai Naik, passed away at the age of 79 in 2005 of a suspected abdominal tumor. Mr. Naik

was educated as a lawyer but was employed by an insurance company in a managerial position. He did not have any history of mental illness or substance abuse. Dr. Desai described her father as "very caring, loving... used to say a lot of jokes... and people loved him." Dr. Desai was close with her father and traveled to India to attend funeral services.

Dr. Desai's mother, Pushpa Naik, passed away at the age of 83 about 3 years ago, on December 29, 2017, of "old age." Ms. Naik did not have any history of mental illness or substance abuse. She was employed at a younger age as a teacher. Dr. Desai described her mother as "very, very loving... helping a lot of people... she had a lot of impact on her students." Dr. Desai visited her mother in India when her mother was very ill, and about one month prior to her death. Dr. Desai commented, "I missed them. They were great parents." Funerals were held according to traditional Hindi practices.

Dr. Desai has two younger brothers. Her youngest brother is 13 years younger than her, lives in New Jersey and works in a financial field. Her other brother lived in India for all of his life and passed away in India on June 26, 2013 at the age 62, "he had a fever, cough, congestion for 2 days... and he had a mild cerebral palsy, studied until 9th grade" and was supported by Dr. Desai's parents.

Regarding her childhood, Dr. Desai described that the family had to frequently move around India, "We lived in different places because my father was transferred frequently, and he was getting promotions." Eventually, when Dr. Desai was in 8th grade they settled in Surat, Gujarat, where Dr. Desai graduated high school, attended college, and then graduated from medical school. When living in Surat, "my parents used to take us to gardens in Mumbai." Dr. Desai explained that there are a variety of parks and points of interest in Mumbai. She recalled, as a child going to movies with her parents, "at the time there was no TV... and in movies it was documentaries." As a child she had no difficulty making friends and loved to play with neighborhood children, "jump rope... hide and seek..." She also lived with her grandparents "for a couple of years." They lived in a rural area by a pond and she enjoyed being in country setting and partaking in related activities.

Dr. Desai denied any history of childhood abuse. She stated that she was a loved child and well cared for by her parents, grandparents and extended family.

Dr. Desai explained that prior to 8th grade she attended multiple schools, at least 4 schools. She always had good grades. After settling in Surat, she completed 12th grade and graduated from high school. Subsequently, she studied science in college. She had excellent grades, which allowed her to apply for medical school. She then attended Government Medical College in Gujarat, and graduated in 5 and a half years. She excelled academically.

Regarding her history of relationships, Dr. Desai never dated. "It was an arranged marriage" when she was about 20 years old, in the second year of medical school, to a young doctor who was practicing in the area. Now, they have been happily married for 50 years. Her husband, Dr. Shirish Desai, is a 77 year old retired internist.

Dr. Desai's marriage produced 3 children, 2 sons and 1 daughter. All of her children are doing well. Her oldest son, Ashish, is 42 year old, is an MBA, works in financial field and lives in Atlanta. The second oldest, Kaushal is 38 year old, also with an MBA degree who works in financial field. Kaushal is married with one child and lives in Boston. Her youngest child, Diane, is 35 years old. She is a pathologist who lives and works in New York. She is married with one child.

Regarding her move to the United States, Dr. Desai explained that her husband came to the US in 1972. She remained in India to complete her studies in medical school and moved to the US in 1974. Her husband's cousin from New Jersey sponsored them. After moving to the US, her husband soon moved to Boston for a job while studying for exams. Then, he began his residency in Worcester City Hospital.

Dr. Desai lived exclusively in Massachusetts since 1974. She passed her tests, started residency in pathology at Mt. Auburn Hospital, but decided to change to radiology, "I didn't like the autopsy part." While a resident at Mt. Auburn, UMass started a residency program in radiology. She transferred to UMass, where she completed her residency and did a fellowship in CT scan and ultrasound. Their family settled in Worcester, MA. They have been living in the same house in Worcester since 1987.

Dr. Desai's husband worked for Cushing Hospital in Framingham until the hospital closed about 30 years ago. He continued to work for Tewksbury Hospital until his retirement in 2002, and since then does locum tenens work.

For about 11 years after completing her residency and fellowship, Dr. Desai joined a group of radiologists at Worcester City Hospital. Dr. Desai explained that at the time Worcester City Hospital had a large volume of patients and they provided coverage for 5 hospitals in the area.

Dr. Desai returned to UMass after her colleague recommended her to do so. She visited the radiology department, met with her peers and with the department chair, Dr. Smith. She was offered a position, which she accepted after about 3 months. Dr. Desai explained that by that time UMass has grown and had a large number of patients.

Dr. Desai started working at UMass on January 6, 1992, until she was terminated from her work on March 17, 2019. Dr. Desai described that about a year before her termination date, on March 14, 2018, she was called for a meeting with the department chair, Dr. Rosen. "I said what is it about? In the room it was him and a higher up, and myself. I walked into room and he just gave me a letter." It was a notice of termination as of March 17, 2019. The letter was dated March 9, 2018. "My first reaction was why? He said, 'No cause' and then he says, 'Your work is of poor quality.' I said, 'Show me the proof.' They said as of this day you are not reading CT scans." Since then, for one year she was reading X-Rays only. "It was like being stabbed in my heart." Dr. Desai explained, "I lived to work. It was the purpose of my life... and somebody stopped it, and without warning." Dr. Desai explained that "the proof" of poor work quality that was presented to her at a later time was made up and inconsistent with reality.

Dr. Desai continued to work until March 17, 2019. She did file grievances but her concerns weren't resolved. She described that the impact of her circumstances was "very devastating." She continues to struggle with the degrading experience of being terminated with no cause, "At night I cannot sleep. I just keep on thinking... why?" She complained that there was no concern for her and what took place was an act of cruelty, "It was a premeditated murder. That's the way I can describe it."

She related that she had warm feelings towards UMass and was highly committed to her work, "Initially, when I started, it was like my home. I had good reviews. Multiple letters of appreciation. They had a lot of confidence in me. I always went extra mile to do it with heart. Other radiologists came to me for opinion... and they said, 'If you go to court, we will come testify for you.' These people (colleagues) had faith in me."

When asked if there was any factual base for her termination, Dr. Desai stated that she had a one complaint from a pulmonologist from Marlboro Hospital, "she would complain about a lot of people" and others had expressed their annoyance with her unfounded complaints.

### **Psychiatric History**

Dr. Desai denied any psychiatric history prior to the events related to termination from her job. She has since been feeling increasingly depressed. She saw Dr. Cutler on 5/28/19. Her husband was concerned about her emotional state and "found Dr. Cutler online... I was reluctant to a psychiatrist... people would think I am crazy." Dr. Desai described her symptoms, "I couldn't sleep, didn't want to do anything... there was nothing to live for... couldn't concentrate, crying and couldn't stop... and even now, I start crying... and with COVID, it didn't help not to have visitors and feeling more isolated."

Dr. Desai expressed that treatment with Dr. Cutler was helpful. She is prescribed Cymbalta and finds it helpful as well. However, "everything now is going on fast track, it's not helping, like constant reminder. Hopefully, it'll be better." Dr. Desai expressed that her sleep remains problematic, sometimes she cannot sleep, and "sometimes a little better... but when I wake up, I can't go back to sleep." She averages 5 hours per night. She has dreams, "sometimes I dream about working there... people, that I can't see. I wake up, think about what happened and can't go to sleep."

Dr. Desai spoke about difficulty coping with her feelings. She has positive feelings about UMass based on years of employment and feeling appreciated and on the other hand, "things changing... I had good feelings, I wanted to retire from that place, I was proud about what I was doing, teaching. I got teacher of the year award..." This type of treatment then being followed by cruel treatment, degradation and termination from work was difficult for her. She spoke about her commitment and pain of rejection from the place she was committed to. "It didn't affect only me. It affected my family, my kids... I'd never do something like that..."

"I cannot drive by UMass, it's a reminder... but sometimes I have to..." since she has to have annual checks of her pacemaker, which was originally placed in about 2000 for sick sinus syndrome. "I don't go to my department to see my colleagues."

Regarding her appetite, she stated, "I eat but I don't feel like eating."

Regarding notation in her record about decreased libido, Dr. Desai explained that her interest in pleasurable activities in general, as well intimacy and sexual activity, has markedly diminished and has not improved.

Regarding effect of Cymbalta, Dr. Desai stated that she is prescribed Cymbalta 60 mg daily. "I think negativity is better and my not wanting to do anything is better... but right now it's worse because too many things..." She returned to discussion of her termination from work. Regarding her plans to retire, Dr. Desai explained that she never thought about retirement, "because work was my life... I lived for work... teaching... residents..." Although she realizes that nothing is forever and at some point, she could face circumstances necessitating changes in her life, however, she could not see herself as deprived from her purpose without any acute need for it. "I go day by day... like I didn't know that I was going to go through this with UMass. The day it happened I thought I was going to have a heart attack... when I came out of the office, I couldn't even stand..."



Dr. Desai stated that she was treated harshly during her last year at work. Her department chair wouldn't greet her. On her last day at work, "one of attendings, he was my medical student, he rotated through radiology... and he got a cake for me and invited me... chairman said nothing, nowhere to be found... but there were a lot of residents, it was at lunch time, there were technicians, secretaries..."

Dr. Desai returned to discussion of therapy with Dr. Cutler. She addresses her feelings regarding the manner of her removal from work, "He does cognitive therapy. He tries to bring out my strengths... but I think I am never going to get out over it... I hope I do."

Regarding her coping mechanisms, Dr. Desai explained that she practices her religion, Hindi. She attends her temple and "one room in my house is a temple... my parents are religious and so I am... you have to help people. That's how I was brought up. I don't understand how people can hurt others." Dr. Desai discussed her religious and cultural beliefs. She speaks Gujarati. She described that she adopted her values from her family. As noted above, her mother was a teacher and father a lawyer. Her paternal grandfather translated a well-known spiritual book to English. Regarding her loss of some family members in India due to COVID-19, Dr. Desai expressed her view, "Life is cycle... everybody who is born has to go when it's your time..." Her religious beliefs help her to deal with life and death related issues and with the grieving process. Although losses of loved ones are devastating, her views on life and death minimized the psychological impact on her throughout her life.

I asked Dr. Desai to describe her average day. She replied, "Now I don't have to work. I get up a little late, tea with husband, then bath, laundry, cooking and all that... I do prayers in the morning... and during the day. Sometimes we go to grocery, sometimes to Indian grocery." She may watch some news. Prior to COVID-19, sometimes "we would meet with friends... stopped during COVID... we are starting again." Her main hobby is reading.

### **Pertinent Medical History**

Dr. Desai identified that she has a condition which "nobody was able to figure it out." She described an incident where "when walking from hospital to garage... and I have a pacemaker... I get a spell; I lose my strength. I just wait, usually for 2 or 3 minutes, most for 5 or 10 minutes." During these episodes her thinking is clear and she remains fully oriented and aware of her environment. "If you talk to me, I'll nod my head, I'm fine." She had seen specialists and had multiple studies, "but nobody figured it out..." She started experiencing these episodes about 20 years ago and it does not interfere with the quality of her work. The episodes are not frequent and usually take place when she feels tired. She knows in advance that she is going to have an episode. Since onset of depression, her husband usually drives the car. Since her termination from work, she rarely drives her car. When driving in the past, which is usually just to the grocery or to work, she would take routes that she is well familiar with and knows where she could pull over. She does not drive on highways. "I drive the same road... and I know when it's coming, and I know the road and where to pull over." At most she may have 2 episodes per week, usually one episode per month, and then no episodes for months. Dr. Desai complained that, in addition to her weekday schedule, she had to periodically cover weekends and this would amount to 12 straight days at work. She explained that her chairman accommodated others, including providing workstations and the option to do weekend coverage from home. "I asked for workstation at home for weekends, but this was declined but he gave it to everybody else."

As noted above, she had a pacemaker placed in about 2000 at UMass for sick sinus syndrome. She has annual in-person follow ups.

Prior to placement of pacemaker, she was diagnosed with hypothyroidism, "I never knew." However, then she developed symptoms, which progressively got worse and necessitated her visit to a doctor for testing for a thyroid condition.

She had a mild hypertension and was prescribed lisinopril, however, her condition has stabilized and she is no longer taking medication.

On review of organ system functions, Dr. Desai did not identify any additional complaints or concerns regarding her cardiovascular, respiratory, gastrointestinal, genitourinary, neurologic or musculoskeletal organ system functions. She denied any history of head trauma. She has never experienced seizures.

**Current Medications:**

- Synthroid 75 mcg daily
- Vitamin D 2000 units daily
- MVI one tablet daily

**Substance Abuse History**

Dr. Desai denied ever using alcohol or any illicit substance.

**Mental Status Examination**

Dr. Desai presented neatly and semi-formally dressed. She identified her weight at 127 lbs. She is 5'5" tall. Her speech was clear with normal tone, volume and rate.

She established good eye contact. Regarding her mood, she stated, "Down." Her affect was constricted. On several occasions during the interview, she started crying. Several short breaks were taken.

Dr. Desai was logical, coherent, and goal-directed. There was no evidence of looseness of association or flight of ideas. She denied ever experiencing auditory or visual hallucinations. She did not verbalize any overt delusions. She denied ever experiencing suicidal ideation. However, she did express during the interview that in the aftermath of her termination from work she felt like she has nothing to live for. When asked if she did not care about her life, she broke down into tears but stated that she has never intended suicide and did not have a suicidal ideation, however, her integrity and dignity were damaged and she did not see a purpose in life. She denied experiencing homicidal ideation.

Dr. Desai was alert and fully oriented to time, place, person and current circumstances. She was able to repeat 3 words, which I asked her to remember and was able to recall the same 3 words after 3 minutes.

When asked to name the Presidents of the United States starting with the current president and in reverse chronological order, she named Presidents Biden, Trump, Obama, and the "the ones from Texas... his brother was running but he lost to Trump..."

She was able to spell "world" forward and backwards effortlessly and without mistakes. She was able to subtract 7s serially from 100 without mistakes.



She was asked to take a clean sheet of paper and draw a face of a clock and place the hands at 20 minutes past 10. She performed this task flawlessly. She was able to correctly copy two overlapping pentagons.

When asked to interpret the proverb, "Don't cry over spilled milk," she replied, "damage is done, crying is not going to help." She interpreted the proverb, "Grass is always greener on the other side of the fence" as "things look better from far... it's not always true."

For the similarity between a cat and a dog, she stated, "both pets." For the similarity between a chair and a table, she stated, "four legs, they are used to sit, eat..."

## SUMMARY OF OPINION

Dr. Charu Desai is a 70-year-old woman of Indian origin, who has been residing in Worcester, Massachusetts since 1974. She was employed at the Department of Radiology at UMass since January 6, 1992. She was promoted to the rank of Associate Clinical Professor. She was terminated from her job on March 17, 2019. Dr. Desai described that she was committed to her work, she "lived for work" and valued her opportunity to practice her profession, teach and be of service to her colleagues, "I went an extra mile." She described being subjected to discriminatory treatment, being denied reasonable accommodations, and then handed a letter of termination on March 14 2018, falsely accused based on unfounded complaints, informing her termination date of March 17, 2019. During the last year at work, she was prevented from reading CT scans despite specialization in this area, per completion of fellowship training at UMass. Dr. Desai had no malpractice law suits and other than allegations presented by her department chair, she had no complaints against her. She was highly regarded by students, residents, technical personnel, and colleagues. During her last year of employment, Dr. Desai filed several grievances but these did not produce any resolution.

Dr. Desai described her reaction to discriminatory treatment culminating in being terminated from work as highly stressful and degrading. She characterized it as "premeditated murder." She explained, "I lived to work. It was purpose of my life. And somebody stopped it, and without warning." She addressed the dichotomy in her feelings. On one hand being a committed and devoted professional and having high regard for her place of employment; and on the other hand, being degraded at the same place by new administration.

As a result of her experiences at workplace, Dr. Desai started seeing a psychiatrist. She noted that she was reluctant to see anyone, however, agreed at the insistence of her husband. She started seeing Dr. Cutler on 5/28/20. Dr. Cutler diagnosed Dr. Desai with Major Depressive Disorder and prescribed an antidepressant, Cymbalta.

As per DSM5, the criteria for diagnosis of Depression are the following:

- A. Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure.

Note: Do not include symptoms that are clearly attributable to another medical condition.

1. Depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad, empty, or hopeless) or observation made by others (e.g., appears tearful). (Note: In children and adolescents, can be irritable mood.)
  2. Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation).
  3. Significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day. (Note: In children, consider failure to make expected weight gain.)
  4. Insomnia or hypersomnia nearly every day.
  5. Psychomotor agitation or retardation nearly every day (observable by others; not merely subjective feelings of restlessness or being slowed down).
  6. Fatigue or loss of energy nearly every day.
  7. Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick).
  8. Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others).
  9. Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide.
- B. The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.
- C. The episode is not attributable to the physiological effects of a substance or another medical condition.

Dr. Desai clearly meets criteria for diagnosis of Depression. She has a persistent depressed mood, loss of interest in pleasurable activities, loss of appetite and sleep disturbances. She feels tired has low energy levels. She is not motivated. She has developed excessive feelings of worthlessness, precipitated by her degrading termination from her work. She perceives herself as with diminished ability to focus or concentrate. Although she denies suicidal ideation, she expressed a sense of desperation in that she lost the meaning of her life, as her identity was in considerable part based on her professional achievements.

Although Ms. Desai does not meet the full criteria of posttraumatic stress disorder, she does have significant symptomatology. She avoids driving by UMass. When she has to visit UMass for her annual checkups, she avoids visiting her department although would like to see some of her colleagues. She correlates the onset of her symptoms with the traumatic experience of humiliating termination, comparing it to "premeditated murder." She wakes up and is unable to go back to sleep because she has distressing and intrusive recollections of the events which took place at her workplace.

Regarding prognosis, clinically the case is complicated as it involves unresolved and conflicting emotions and significant cognitive dissonance. On one hand, Dr. Desai is expressing warm and positive feelings towards her institution and has a deep sense of appreciation for her education, professional development and privilege to practice. On the other hand, she is highly traumatized by the same institution. This resembles a persisting and highly abusive relationship, which culminated in degrading disposal, and is unlikely to be resolved.

To summarize, it is my opinion with a reasonable degree of medical certainty that Dr. Charu Desai meets criteria for diagnosis of Major Depressive Disorder, which has become chronic. In addition, she has

considerable symptomatology of Posttraumatic Stress Disorder. Her mental conditions were precipitated and are a direct result of her experiences at her workplace. Her prognosis is poor.

The above report and opinion are based on my interview of Dr. Charu Desai and review of available collateral information. All opinions in this report are expressed to a reasonable degree of medical certainty. Should any additional information become available, I reserve my right to review it and consider it in conjunction with my opinion. Should you have any questions, please do not hesitate to contact me.

Respectfully submitted,

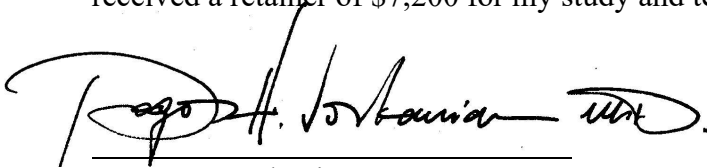
  
Pogoh H. Voskenian, M.D.

Diplomate of American Board of  
Psychiatry and Neurology in  
Psychiatry and Forensic Psychiatry

**As required by F. R. Civ. Pro. 26(a)(2)(B) regarding the opinions of expert witnesses I further state the following:**

Attached is a copy of my current curriculum vita, which includes a list of cases that I have testified in over the past four years current as of this date.

I hereby state that I am being compensated as an expert in this case at the rate of \$360.00 per hour. I have spent approximately 24 hours up to this point on this case, and have received a retainer of \$7,200 for my study and testimony.

A handwritten signature in black ink, reading "Pogós H. Voskanian, M.D.", with a horizontal line underneath.

Pogos H. Voskanian, M.D.  
Diplomate of American Board of  
Psychiatry and Neurology in  
Psychiatry and Forensic Psychiatry

# Exhibit C

**UNITED STATES DISTRICT COURT  
DISTRICT OF MASSACHUSETTS**

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CHARU DESAI,

Plaintiff,

v.

UMASS MEMORIAL MEDICAL  
CENTER, INC.; UMASS MEMORIAL  
MEDICAL GROUP; UNIVERSITY OF  
MASSACHUSETTS MEDICAL SCHOOL,  
UMASS MEMORIAL MARLBOROUGH  
HOSPITAL, MAX ROSEN, M.D.,  
DARREN BRENNAN, M.D.,  
STEPHEN TOSI, M.D.,  
AND KARIN DILL, M.D.,

Defendants.

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CIVIL ACTION NO.:  
**4:19-CV-10520-DHH**

**PLAINTIFF CHARU DESAI'S EXPERT WITNESS DISCLOSURE**

The Plaintiff, Charu Desai, M.D., by and through her attorneys, discloses the witness listed below may be called at trial to offer expert testimony.

I. *Disclosure – Michael Morrison, Ph.D.*

Plaintiff expects to call Michael Morrison, Ph.D., to offer expert opinion testimony. Dr. Morrison is a tenured Assistant Professor of Economics at Edinboro University of Pennsylvania and the Assistant Department Chair of the Department of Business and Economics. He earned a Bachelor of Sciences in Economics in 2004 from Montana State University in Bozeman, Montana. Dr. Morrison then earned a Master's degree in Economics in 2012, at the University of New Mexico, in Albuquerque, New Mexico. He earned his Ph.D. in economics in 2013, also at the University of New Mexico. Dr. Morrison has substantial teaching experience, having

taught economics for over ten years. Dr. Morrison has also published several papers, presented at conferences, and given numerous lectures in the field of economics.

Dr. Morrison's report includes a complete statement of all opinions to be expressed and the basis and reasons therefore, the information considered in forming the opinions, and any exhibits to be used as a summary of or support for the opinions; a copy of his curriculum vitae, which details Dr. Morrison's qualifications; a listing of all publications Dr. Morrison authored within the preceding ten (10) years; and a listing of other cases Dr. Morrison has testified at trial or by deposition in the preceding four (4) years. In this case, Dr. Morrison is being compensated \$1,750 for his study and a rate of \$350.00 for any additional testimony.

Plaintiff expects that Dr. Morrison will offer testimony on issues related to lost economic benefits, including salary and retirement benefits, due to her employment discrimination.

More specifically, Dr. Morrison will testify concerning the below:

- The present value of Plaintiff's lost past and future earnings as a result of her termination; and
- The present value of Plaintiff's reduced quality of life associated with her major depressive disorder, which resulted from Dr. Desai's termination.

## II. *Reservation of the Right to Rebut and Comment*

Plaintiff reserves the right to supplement and amend this disclosure as discovery is ongoing. Plaintiff reserves the right to have her expert critique, comment upon and rebut the testimony and opinions of the Defendant's experts, if any. Plaintiff further reserves the right to call as an expert witness any person disclosed by the Defendant as an expert witness. Plaintiff reserves the right to elicit from such witness testimony on any of the issues in this case without specifically adopting the testimony and opinions of the Defendant or the Defendant's experts.

Respectfully Submitted,

CHARU DESAI,  
By her attorneys,

/s/ Patricia A. Washienko  
Patricia A. Washienko, BBO# 641615  
[pwashienko@fwlawboston.com](mailto:pwashienko@fwlawboston.com)  
Brendan T. Sweeney, BBO # 703992  
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FREIBERGER & WASHIENKO, LLC  
211 Congress Street, Suite 720  
Boston, MA 02110  
p: 617.723.0008 f: 617.723.0009

Dated: August 1, 2021

**CERTIFICATE OF SERVICE**

I, Brendan T. Sweeney, hereby certify that a true and accurate copy of the foregoing document was served upon attorneys for the Defendants herein, by electronic mail.

/s/ Brendan T. Sweeney  
Brendan T. Sweeney

Dated: August 1, 2021



# Exhibit D

**Michael Morrison Ph.D.**  
**Economic consulting**

5205 Caprock Dr. NE, Rio Rancho, NM 87144  
Tel: 505-231-0041  
Mtmichael@gmail.com

**Economic Report**

**To:** Patricia A. Washienko, Esq.  
**From:** Michael Morrison Ph.D.  
**Date:** 07/27/2021  
**Re:** *Dr. Desai v. UMass Memorial Health, et al.*

**Part I Background**

Dr. Desai is a 71 year old (July 6, 1950) woman residing in Worcester, Massachusetts who was a radiologist at the UMass Memorial Health (“Employer”). She was hired 27 years ago (in 1992) as a Radiologist and served as Radiologist until March 17, 2019.

It is my understanding that prior to her termination Dr. Desai was paid \$340,000.00 per year in salary as well as receiving an 8% contribution to her 401k plan, life insurance coverage valued at \$50,000.00, and Continuing Medical Education expenses valued at \$4,000.00 per year. Dr. Desai was employed at UMass Hospital for 27 years and planned to continue her employment for an additional 10 years. On March 17, 2019, Dr. Desai’s employment was terminated from UMass Hospital.

Dr. Desai believes she was terminated due to discrimination. As a direct result of Dr. Desai’s termination, she was diagnosed with major depressive disorder and has been in the care of psychiatrist and on medication since her diagnosis on May 25, 2020.

Prior to her termination of employment, Dr. Desai learned that a younger co-worker was receiving in addition to their regular compensation 1.5 academic/administrative days per week. On academic/administrative days the co-worker was not required to perform clinical duties. Dr. Desai also is aware that another younger co-worker was paid \$10,000 per year more than her since 2016. Dr. Desai contends that this is further evidence of discrimination.

**Assignment**

I have been retained to form an opinion to a reasonable degree of economic certainty as to the present value of lost earnings and the value of reduced quality of life associated with major depressive disorder resulting from Dr. Desai’s termination.

### **The Basis for Economic Damages**

Economic damages related to lost earnings are based on the economic concept of *opportunity cost*. If, as a result of an illegal act, a person is deprived of the opportunity to earn a living, the resulting damages are equal to the cost of restoring the injured person's lost opportunity or providing what would have reasonably been the fruits of exercising it. In this case, it is alleged that Dr. Desai was wrongfully terminated due to discrimination. Her early termination prevented Dr. Desai from continuing to work. Additionally her termination caused her to develop major depressive disorder, which reduced her quality of life; preventing her from fully enjoying her leisure time. The calculation of the value of the reduced quality of life is a 3-part process.

1. Establishing the value of time. This has been done based on the employee's contractual salary as of \$340,000.00/year, which represents an agreement between Employer and Dr. Desai about the minimum value of her time. This number is converted to a daily rate, assuming a 52-week contract. This figure is then applied to a full 24-hour day. This number represents what Dr. Desai is willing to accept for 24 hours of her time. This isn't related to Dr. Desai's employability, instead it is Dr. Desai's value of her leisure time.
2. Establishing the reduction in quality of life. This is a measure of how much the major depressive disorder has reduced her quality of life. This is essentially the same concept as quality-of-life adjusted life expectancy. Through a survey of relevant academic research (from refereed sources), several "suffering multipliers" have been gathered. A corresponding value of reduced quality of life has been calculated for each multiplier and is reported in Part IV below.
3. Establishing the duration of suffering. This has been calculated from the date of termination and the date of diagnosis of major depressive disorder.

### **Part II Lost Earnings**

For this analysis I am defining the period of lost earnings to be from March 17, 2019, to July 27, 2021. Lost salary, 401k contributions, lost continuing medical education funding, and unawarded academic/administrative days are included in this calculation. Life insurance costs have not been calculated as I understand Dr. Desai is asking Employer to secure an equivalent life insurance policy for Dr. Desai.

#### **Lost Salary**

At her the time of her termination, Dr. Desai was earning an annual salary of \$340,000.00. Dr. Desai has stated her intention of continuing to work until at least 2029, so future lost earnings are calculated for 10 years. According to the U.S. Bureau of Labor Statistics<sup>1</sup> the inflation rates for March 2019 to February 2020 and March 2020 to July

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<sup>1</sup> CPI – for All Urban Consumers, Bureau of Labor Statistics <https://data.bls.gov/cgi-bin/surveymost>. Updated Jul 2021, accessed Jul 2021

2021 are 1.54% and 5%. The expected annual inflation rate from August 2021 to March 2029 is 1.61%<sup>2</sup>. Additionally, O-Net from the U.S. Department of Labor<sup>3</sup> reports an expected 4% growth in the radiologist profession over the next 10 years. This value is used as a proxy for salary growth from March 2019 until March 2029. Values for lost salary assuming no inflation or salary growth, inflation adjusted, and inflation and salary growth adjusted are reported below.

### **Lost 401k Contributions**

In addition to her salary, earnings also include the value of 401k contributions Dr. Desai received. Dr. Desai reports that UMass Hospital contributed 8% of her salary to her 401k. Without knowing how Dr. Desai's 401k is invested, the lost 401k contributions are calculated using known growth in the S&P 500 from March 2019 to July 2021, and the expected growth rate of the S&P 500 as reported by S&P 500 Global Market Intelligence<sup>4</sup> for the next 10 years. As with the lost salary calculations, the lost 401k contributions are calculated assuming no salary growth, inflation adjusted, and inflation and salary growth adjusted salaries are used for the 401k contributions. The values are reported below.

### **Lost Academic/administrative days**

The value of lost academic/administrative days are calculated with no salary growth, inflation adjusted and inflation, and salary growth adjusted annual salaries. The value of lost academic/administrative days are calculated based on the following equation

$$Value\ of\ Academic\ days = 1.5 * \frac{Salary}{52\ weeks * 5\ days}$$

Values are calculated for 10 years using no salary growth, inflation adjusted, and inflation and salary growth adjusted salaries. The values are reported below.

### **Lost Continuing Medical Education**

The value of lost Continuing Medical Education is calculated assuming an annual value of \$4,000.00 per year as reported by Dr. Desai. The values are reported below.

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<sup>2</sup> Inflation Expectations, Federal Reserve Bank of Cleveland <https://www.clevelandfed.org/our-research/indicators-and-data/inflation-expectations.aspx>. Updated Jul 2021, accessed Jul 2021.

<sup>3</sup> O-Net Online 29-1224.0 Radiologist, U.S. Department of Labor <https://www.onetonline.org/link/summary/29-1224.00>. Updated 2020, accessed Jul 2021

<sup>4</sup> Scheid, Brian, "S&P 500 returns to halve in coming decade – Goldman Sachs", Jul 15 2020, <https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/s-p-500-returns-to-halve-in-coming-decade-8211-goldman-sachs-59439981>.

### **Part III Value of Reduced Quality of Life**

#### **Establishing Value of Time**

Dr. Desai's value of time is estimated using her salary at the time of termination, as the last mutually agreed upon value of Dr. Desai's time. The value of a day of Dr. Desai's time is calculated using the following equation.

$$\text{value of a day} = 24 \frac{\text{hours}}{\text{day}} * \left( \frac{\text{Salary}}{52 \frac{\text{weeks}}{\text{year}} * 40 \frac{\text{hours}}{\text{week}}} \right)$$

Using the equation above, one day of Dr. Desai's time is valued at \$3,924.08

#### **Establishing Reduction in Quality of Life**

The reduction in quality of life was determined by a close examination of the extant literature on the effects of depression on quality of life. Jia, et al in 2015<sup>5</sup> determined depressive symptoms and quality of life scores for 276,442 individuals. It was determined that the quality of life for all participants was reduced by 33.92%, and 60.74% for the over 65 group.

Steensma et al in 2016<sup>6</sup> used the Canadian Community Health Survey as well as the Health Utilities Index to calculate health related quality of life measures. The authors found that quality of life was reduced by 32.18% for those with depression.

IsHak et al 2015<sup>7</sup> calculate the improvement in quality of life for 2,280 adults following several different interventions. As part of their work the authors calculated that major depressive disorder reduced quality of life by an average of 49.1%

Values of suffering were calculated for each of the reduction in quality-of-life values listed above and are reported below.

#### **Establishing Duration of Suffering**

Values of suffering were calculated since the date of diagnosis (5/15/2020) as well as the date of termination (3/17/2019) and are reported below.

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<sup>5</sup>Jia, Haomiao, Matthew M. Zack, William W. Thompson, Alex E. Crosby, and Irving I. Gottesman.

"Impact of depression on quality-adjusted life expectancy (QALE) directly as well as indirectly through suicide." *Social psychiatry and psychiatric epidemiology* 50, no. 6 (2015): 939-949.

<sup>6</sup>Steensma, C., L. Loukine, H. Orpana, L. McRae, J. Vachon, F. Mo, M. Boileau-Falardeau, C. Reid, and B. C. Choi. "Describing the population health burden of depression: health-adjusted life expectancy by depression status in Canada." *Health promotion and chronic disease prevention in Canada: research, policy and practice* 36, no. 10 (2016): 205.

<sup>7</sup>IsHak, Waguhi William, James Mirocha, David James, Gabriel Tobia, Jennice Vilhauer, Hala Fakhry, Sarah Pi et al. "Quality of life in major depressive disorder before/after multiple steps of treatment and one-year follow-up." *Acta Psychiatrica Scandinavica* 131, no. 1 (2015): 51-60.

**Part IV Value of Reduced Quality of Life and Lost Earnings**

The values reported in this section are raw values and not present value adjusted. Present-value adjusted values are reported in the following section.

**Value of Lost Wages**

The calculated values for lost earnings are reported below:

No Inflation:	\$3,400,000.00
Inflation:	\$3,645,456.84
Inflation and Salary Growth:	\$3,912,436.69

**Value of Lost 401k Contributions**

The calculated values for lost 401k contributions is reported below.

No Inflation adjustment in salary:	\$3,723,757.00
Inflation adjustment in salary:	\$4,253,600.71
Inflation and Salary Growth	\$4,820,015.51

**Value of Lost Academic/Administrative Days**

Total Loss to date:	\$239,307.69
Expected Loss:	\$778,730.77

**Value of Lost Continuing Medical Education**

Total loss (to date and expected):	\$40,000.00
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**Value of Reduced Quality of Life**

Values are reported assuming Dr. Desai was suffering from major depressive disorder from the moment of her termination, and since the date of the official major depressive disorder diagnosis. As well as, using the reduced quality of life values calculated by Jia, et al (2015) (both total and 65+), Steensma, et al (2016), and IsHak, et al (2015).

Duration	Jia, et al 2015		Steensma, et al 2016	IsHak, et al 2015
	65+	All		
Since 3/17/2019	\$10,741,983.84	\$5,999,299.28	\$5,691,798.41	\$6,261,194.06
Since 5/25/2020	\$9,705,434.83	\$5,420,396.18	\$5,142,567.64	\$5,423,283.68

**Present Value**

Once the value of lost future earnings has been established, it must be reduced to present value. That is, one must determine how much money would have to be set aside and invested today to provide that future loss in earnings. The only element that is uncertain in calculating the present value is the net rate of return that will be earned on the funds that are invested for future use. Because the loss of future earnings are estimated using the

current value of the dollar (net of inflation), they are discounted using an expected rate of return that is also real (net of inflation).

The discount rate used here to determine the present value of future lost earnings is calculated using the 10-year treasury rate.<sup>8</sup>

#### **Present Value of Lost Earnings**

The calculated values for lost earnings are reported below:

No Inflation:	\$3,217,197.29
Inflation:	\$3,461,050.14
Inflation and Salary Growth:	\$3,708,661.02

#### **Present Value of Lost 401k Contributions**

The calculated values for lost 401k contributions are reported below.

No Inflation adjustment in salary:	\$3,288,751.16
Inflation adjustment in salary:	\$3,756,699.01
Inflation and Salary Growth	\$4,256,945.76

#### **Present Value of Lost Academic/Administrative Days**

Total Loss	\$927,067.85
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#### **Present Value of Lost Continuing Medical Education**

Total loss (to date and expected):	\$35,327.24
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#### **Present Value of Reduced Quality of Life**

Values are reported assuming Dr. Desai was suffering from major depressive disorder from the moment of her termination, and since the date of the official major depressive disorder diagnosis. As well as, using the reduced quality of life values calculated by Jia, et al (2015) (both total and 65+), Steensma, et al (2016), and IsHak, et al (2015).

Duration	Jia, et al 2015		Steensma, et al 2016	IsHak, et al 2015
	65+	All		
Since 3/17/2019	\$9,725,952.26	\$5,431,854.97	\$5,153,439.10	\$7,862,123.50
Since 5/25/2020	\$8,689,403.24	\$4,852,951.87	\$4,604,208.33	\$7,024,213.12

#### **Summary of Findings**

Based on the information I have available at the present time; I have formed an opinion to a reasonable degree of economic certainty that Dr. Desai's present value losses to date range from \$1,535,807.33 to \$6,081,293.11. Her present value future losses range from \$10,536,744.55 to \$12,572,661.02. Dr. Desai's present value present and future losses because of her termination and the resulting major depressive disorder diagnosis range

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<sup>8</sup> Treasury yields

from \$12,072,551.88 to \$18,653,954.13. These values are calculated based on lost earnings, 401k contributions, academic/administrative days, continuing medical education fund and reduced quality of life associated with a diagnosis of major depressive disorder. These values are calculated assuming Dr. Desai would have worked an additional 10 years beyond her date of termination.

This opinion is based on the information I have at this time. I reserve my right to supplement this opinion as any new information becomes available that would materially change the damages in the case such as changes in interest rates, a change in Dr. Desai's current or additional diagnoses, or a change in actual or expected inflation rates.

**As required by Federal Rule 26(b) regarding the opinions of expert witnesses  
I state the following:**

In forming my opinion in this matter I have relied upon the following information:

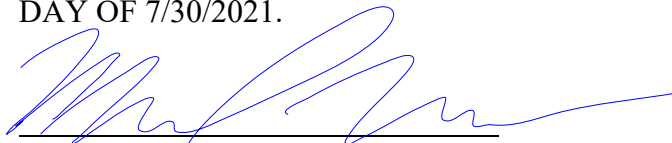
1. Information provided by Patricia A. Washienko, Esq., set out in Appendix A.
2. Information from public published sources as footnoted in my report.

Attached is a copy of my current curriculum vita, which includes a list of all my publications in the last 10 years.

I hereby state that I am being compensated as an expert in this case at the rate of \$1,750 for this report and \$350 per hour for any additional work. I have spent approximately 6 hours up to this point on this case.

Attached is a copy of cases that I have testified in over the past 4 years and it is current as of this date.

SIGNED UNDER THE PAINS AND PENALTIES OF PERJURY ON THIS  
DAY OF 7/30/2021.

  
Michael Morrison Ph.D.



**Michael Morrison Ph.D.**  
**Economic consulting**

5205 Caprock Dr. NE, Rio Rancho, NM 87144  
Tel: 505-231-0041  
Mtmichael@gmail.com

**Economic Report - Addendum**

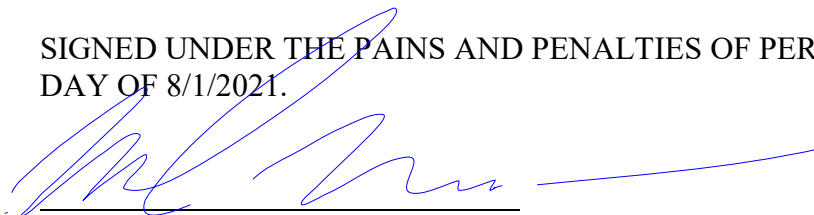
**To:** Patricia A. Washienko, Esq.  
**From:** Michael Morrison Ph.D.  
**Date:** 07/27/2021  
**Re:** *Dr. Desai v. UMass Memorial Health, et al.*

**Addendum**

Dr. Desai's termination and major depressive disorder diagnosis forced Dr. Desai's husband, Shirish Desai, to prematurely retire as well. Mr. Desai had also planned to work for an additional 10 years. At his current salary of \$150,000 per year. The present value of total lost salary is between \$1,419,351.75 and \$1,570,077.18. Lost salary values are calculated based on the assumption of no salary growth and inflation adjusted annual salary. Values for actual and expected inflation are the same as in the main report.

I hereby state that I am being compensated as an expert in this case at the rate of \$1,750 for the main report and \$350 per hour for the addendum and any additional work. I have spent approximately 1 hour on this addendum and 7 hours total on this case.

SIGNED UNDER THE PAINS AND PENALTIES OF PERJURY ON THIS  
DAY OF 8/1/2021.

  
\_\_\_\_\_  
Michael Morrison Ph.D.

**Previous Cases:**

I have not testified in any cases as of July 28, 2021

I have provided an Economic Impact Report for Tim Kolman, Esq. for an EEOC complaint.

# Appendix A

Charu Desai was born on July 6, 1950. She resides in Worcester, Massachusetts.

Dr. Desai is a radiologist. She began working at UMass in the Department of Radiology in 1992. Dr. Desai was informed of her termination on March 17, 2018. Her termination became effective March 17, 2019.

As of the effective date of Dr. Desai's termination, she had worked at the UMass entities for 27 years. She planned to finish out her career there. She had no immediate plans to retire; rather, she expected to work at least ten (10) more years (i.e., until March 2029, when she would be 78 years of age).

At the time of her termination, Dr. Desai was paid an annual salary of \$340,000. Dr. Desai believes that her employer matched her 401(k) contribution at 8%.

Throughout her employment, Dr. Desai also received life insurance coverage. Due to her age and health condition, it is cost prohibitive for her to purchase comparable life insurance (a \$50k death benefit) on the open market. (As part of her damages / part of the resolution of this matter, Dr. Desai seeks to secure a life insurance policy in the amount of \$50,000 from Defendants, or, alternatively, that Defendants provide her with payment in that amount.)

Dr. Desai has incurred losses in the amount of approximately \$9,000 in lost Continuing Medical Education Fund benefits (\$4,000 annually).

Dr. Desai was not awarded "academic days" on which days she would not have been required to perform clinical duties. Younger doctors were granted academic days. A younger radiologist, who was hired three years before Dr. Desai's termination, was given one and one-half academic and/or administrative days per week (i.e., 78 per year).

Dr. Desai also is aware that another younger co-worker was paid \$10,000 per year more than her since 2016.

Since her termination, Dr. Desai has diligently searched for another radiology position but has not secured or even been offered one.

In March 2019, Dr. Desai's husband, also a medical doctor, stopped doing locum tenens work, for which work he earned approximately \$150k annually, to care for her, as she was so distressed by her termination it impacted her day-to-day functioning. He has not performed any locum tenens work since then.

Dr. Desai was diagnosed on 5/25/2020 with major depressive disorder and has been in the care of a psychiatrist (and on medication) since that time.

**Michael Morrison**  
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5205 Caprock Dr.  
Rio Rancho, NM 87144  
Home: (505)231-0041, Office: (814)731-1657  
Email: mmorrison@edinboro.edu

## **EMPLOYMENT HISTORY**

Assistant Professor (tenured) at Edinboro University of Pennsylvania (August 2013-Present)

## **EDUCATION**

Ph.D. Economics, University of New Mexico, Albuquerque, NM August 2013  
M.A. Economics, University of New Mexico, Albuquerque, NM August 2012  
B.S. Economics, Montana State University, Bozeman, MT 2004

## **DISSERTATION      The Law of One Price and Virtual Worlds**

*Part I. "Virtual World Research in the Social Sciences"*

*Part II. "Price Convergence after Cataclysm"*

*Part III "STAR modeling of Band of Inaction Variations"*

Committee: Prof. Matías Fontenla (Co-Chair), Prof. Christine Sauer (Co-Chair), Prof. Alok Bohara, Prof. Christopher Butler

## **FIELDS OF SPECIALIZATION**

Primary: International Economics

Secondary: Development Economics and Environmental Economics

## **PUBLICATIONS AND PAPERS**

### *Publications*

Morrison, Michael, and Matías Fontenla. "Price Convergence in an Online Virtual World."  
Empirical Economics (2013): 1-12.  
Morrison, Michael and Matías Fontenla. "Purchasing Power Parity across Eight Worlds,"  
Economics Letters 158 (2017): 62-68.

### *Works in Progress*

Morrison, Michael and Christine Sauer. "Band of Inaction Variations in Response to Changes in Transaction Costs," Working Paper  
Morrison, Michael and Scott Duda. "The Balance of Payments and the Band of Inaction," Working Paper  
Morrison, Michael. "The Harrod-Balassa-Samuelson Effect and the Band of Inaction," Working Paper.  
Morrison, Michael and Kyle Hurysz. "Impact of BP Oil Spill on Aggregate Transportation Costs," Working Paper.  
Dexter, John, Michael Morrison, Da Ler, and Tara Lambert. "Increasing the Likelihood of Sitting for the CPA Examination: Effects of Incorporating CPA Review Course Materials in Intermediate Accounting Classes," Working Paper

### *Conference Presentations*

Morrison, Michael and Christine Sauer, "The Variable Band of Inaction: Transaction Costs and the Size of the Band of Inaction," Southwestern Social Science Association 2018 Annual Meeting, Orlando, FL 2018  
Morrison, Michael and Dennis Barber III, "What can Virtual Behavior offer to Entrepreneurship Education," Southeast Decision Science Institute, Savannah, GA 2015  
Morrison, Michael and Dennis Barber III, "Does the EAO Remain Valid in the Virtual World," Pennsylvania Economic Association Conference, Edinboro, PA 2014  
Morrison, Michael and Matías Fontenla "Price Convergence After Cataclysm," 56<sup>th</sup> annual Western Social Science Association Conference, Albuquerque, NM 2014

Morrison, Michael and Christine Sauer, "Variable Band of Inaction: Transaction Costs and the Size of the Band of Inaction," 56<sup>th</sup> annual Western Social Science Association Conference, Albuquerque, NM 2014

Morrison, Michael and Matías Fontenla, "Price Convergence in an Online Virtual World," 91<sup>st</sup> annual Southwestern Social Science Association Meeting, Las Vegas, NV. 2011

Morrison, Michael "Estimating and International Property Rights Value for Haiti," 51<sup>st</sup> annual Western Social Science Association Conference, Albuquerque, NM. 2009

Morrison, Michael "Testing the Purchasing Power Parity Hypothesis within an Online Virtual Economy," 89<sup>th</sup> annual Southwestern Social Science Association Meeting, Denver, CO. 2009

#### *Other Presentations*

Morrison, Michael and Matias Fontenla. "Purchasing Power Parity across Eight Worlds," Edinboro University Academic Festival, Edinboro, PA 2017

Morrison, Michael "Price Convergence after Cataclysm" Faculty Research Presentation at Porreco, Erie, PA 2016

Morrison, Michael "Unemployment in the U.S. Structural or Cyclical?" Al Stone Lecture Series, Edinboro, PA 2014

Morrison, Michael and Matías Fontenla, "Price Convergence after Cataclysm," Department of Business and Economics Research Symposium Series, Edinboro, PA. 2013

#### **TEACHING EXPERIENCE**

International Finance, Edinboro University of Pennsylvania, fall 2018-present

Econometrics, Edinboro University of Pennsylvania, spring 2015-present

International Economics, Edinboro University of Pennsylvania, spring 2014-present

Economic Development, Edinboro University of Pennsylvania, fall 2013-present

Principles of Macroeconomics, Edinboro University of Pennsylvania, 2014- present

Principles of Microeconomics, Edinboro University of Pennsylvania, fall 2013-spring 2018

Career Preparation Seminar, fall 2015-spring 2016

Business Primer, Edinboro University of Pennsylvania, fall 2014, fall 2016

Intermediate Macroeconomics, University of New Mexico, summer 2011–fall 2012

Introductory Macroeconomics, University of New Mexico, spring 2010–winter 2012.

#### **RESEARCH/WORK EXPERIENCE**

*Research Assistant, David Brookshire, Albuquerque, NM, summer 2008-fall 2009*

Responsibilities included assisting, in implementation of economic experiments, designing, printing and distributing an online and mail contingent valuation method (CVM) and choice experiment (CE) survey.

#### **PROFFESIONAL HONORS**

Nominated for Faculty Member of the Year at Edinboro University of Pennsylvania, 2016-2017 academic year.

Southern Economic Association sponsored graduate student presentation, \$155, November 2012

#### **RESEARCH FUNDING**

Research Travel Projects Grant, Office of Graduate Studies University of New Mexico, "Price Convergence in a Virtual World, March 2011, \$700

#### **SERVICE**

Expert Witness for Kolman Law P.C. Summer 2021

Project Lead/Primary Contributor ACBSP decennial re-accreditation report Fall 2020

Assistant Department Chair, Department of Business and Economics, summer 2017-present

Chair, Elections and Nominations Committee, APSCUF (faculty union) spring 2019-

present

Member, Board of Directors, Erie Humane Society (formerly Humane Society of Northwest Pennsylvania), spring 2019 - present

Faculty Member, Presidential Working Group #2, spring 2017

Co-Adviser, Business and Economics Club, spring 2016 - present

Adviser, Alpha Kappa Psi – Business Fraternity, spring 2016- present

Co-Adviser, Delta Mu Delta – Business Honor Society, spring 2016 - presents

Founding member, Humanity and Sustainability Institute, fall 2015-present.

Co-Chair, General Education Redesign Task Force, Edinboro University of Pennsylvania, fall 2013-summer 2016.

Referee, Energy Economics 2014

Student Recognition Committee, Department of Business and Economics, Edinboro University of Pennsylvania, fall 2013-Present.

Economics Comprehensive Exam Committee, Department of Business and Economics, Edinboro University of Pennsylvania, fall 2013-Present.

Sabbatical Leave Committee, Department of Business and Economics, Edinboro University of Pennsylvania, fall 2013-Present.

Department Secretary, Department of Business and Economics, Edinboro University of Pennsylvania, fall 2013-spring 2014.

Referee, Applied Economics – 2011, 2019

#### **CURRICULUM DEVELOPMENT**

Co-Presenter, Center for Faculty Excellence, “Teaching Critical Thinking Effectively,” Edinboro University of Pennsylvania, September 2018 and February 2019.

Participant, OSET Workshop, “Designing Courses for Effective Student Learning,” UNM, May 2010 and August 2011.

#### **TECHNICAL SKILLS**

STATA, RATS, MS OFFICE GNPLOT, SPSS, SQL

#### **MEDIA APPEARANCES**

Wired Magazine, “Bot Mafias Have Wreaked Havoc in *World of Warcraft Classic*,” June 17, 2020. <https://www.wired.com/story/world-of-warcraft-classic-russian-bots/>



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*Acta Psychiatr Scand.* 2015 January ; 131(1): 51–60. doi:10.1111/acps.12301.

## Quality of Life in Major Depressive Disorder Before/After Multiple Steps of Treatment and One-year Follow-up

**Waguih William IsHak, MD, FAPA,**

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Department of Psychiatry and Behavioral Neurosciences, Cedars-Sinai Medical Center, Los Angeles, California, United States.

**David James, B.A.,**

Stanford University and Department of Psychiatry and Behavioral Neurosciences, Cedars-Sinai Medical Center, Los Angeles, California, United States.

**Gabriel Tobia, M.D.,**

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**Jennice Vilhauer, Ph.D.,**

Departments of Psychiatry, Emory University School of Medicine, Atlanta, Georgia, and Cedars-Sinai Medical Center, Los Angeles, California, United States.

**Hala Fakhry, M.D.,**

Department of Psychiatry, Faculty of Medicine, Cairo University, Cairo, Egypt.

**Sarah Pi, B.S.,**

Department of Psychiatry and Behavioral Neurosciences, Cedars-Sinai Medical Center, and University of California, Los Angeles, Los Angeles, California, United States.

**Eric Hanson, Ph.D. candidate,**

Loma Linda University, Loma Linda, California, United States.

**Rama Nashawati, M.S.,**

University of Southern California and Cedars-Sinai Medical Center, Los Angeles, California, United States.

**Corresponding Author:** Waguih William IsHak, M.D., FAPA, Vice Chairman for Education and Research, Cedars-Sinai Medical Center, Department of Psychiatry and Behavioral Neurosciences, 8730 Alden Drive, Thelians E-132, Los Angeles, CA 90048, USA. Phone (310) 423-3513, Fax (310) 423-3947, Waguih.IsHak@cshs.org.

**Trial Registration:** National Institute of Mental Health (NIMH) # NCT00021528. <http://www.clinicaltrials.gov/ct/show/NCT00021528>

### Declaration of interest

Dr. IsHak received research grant support unrelated to this manuscript from:

NARSAD: Quality of Life in Major Depressive Disorder, 2005–2007

Pfizer: Ziprasidone monotherapy for Major Depressive Disorder, 2007–2011

None of the other authors have any conflicts of interest.



**Eric D. Peselow, M.D., and**

Richmond University Medical Center and Freedom From Fear, Staten Island, New York, United States.

**Robert M. Cohen, Ph.D., M.D.**

Department of Psychiatry, Emory University School of Medicine, Atlanta, Georgia, United States.

## Abstract

**Objective**—This study examines the impact of Major Depressive Disorder (MDD) and its treatment on Quality of Life (QOL).

**Method**—From the Sequenced Treatment Alternatives to Relieve Depression (STAR\*D) trial, we analyzed complete data of 2,280 adult MDD outpatients at entry/exit of each level of antidepressant treatments and after 12-months of entry to follow-up. QOL was measured using the Quality of Life Enjoyment and Satisfaction Questionnaire (Q-LES-Q). The proportions of patients scoring ‘within-normal’ QOL (within 10% of Q-LES-Q community-norms) and those with ‘severely-impaired’ QOL (>2SD below Q-LES-Q community-norms) were analyzed.

**Results**—Before treatment, no more than 3% of MDD patients experienced ‘within-normal’ QOL. Following treatment, statistically significant improvements were detected, however the proportion of patients achieving ‘within-normal’ QOL did not exceed 30%, with >50% of patients experiencing ‘severely-impaired’ QOL. Although remitted-patients had greater improvements compared to non-remitters, 32%-60% continued to experience reduced QOL. 12-month follow-up data revealed that the proportion of patients experiencing ‘within-normal’ QOL show a statistically significant decrease in non-remitters.

**Conclusion**—Symptom-focused treatments of MDD may leave a misleading impression that patients have recovered when, in fact, they may be experiencing ongoing QOL deficits. These findings point to the need for investigating specific interventions to ameliorate QOL in MDD.

## Keywords

Quality of Life; Major Depression; Antidepressants; Functional Outcomes; Patient-reported outcomes

## INTRODUCTION

According to the World Health Organization (WHO), quality of life (QOL) represents the individual’s subjective evaluation of physical, mental, and social domains (1). Major depressive disorder (MDD), which is the leading cause of disability globally affecting nearly 350 million people worldwide (2), is associated with substantial deficits in QOL (3,4). Importantly, QOL deficits have been shown to persist beyond the clinical resolution of symptoms (5), placing patients at an increased risk for relapse and rising direct and indirect costs (6). A poor QOL often overlaps with depressive symptom severity (7). However, a number of studies have shown that the severity of depressive symptoms explained only a small proportion of the variance in QOL (3, 4, 8). These findings suggest that assessing symptom reduction alone may not be the best way to gauge the success of MDD interventions. Despite being increasingly recognized as an important measure of health in

medical and psychiatric patients (9, 10), QOL needs to be given more attention in clinical and research efforts in MDD.

To fully assess the impact of MDD and its treatment on QOL, we analyzed QOL data from the Sequenced Treatment Alternatives to Relieve Depression (STAR\*D) trial (11, 12), the largest prospective randomized study of treatment effectiveness for outpatients with MDD. Previous STAR\*D reports have already shed some light on QOL in MDD (13, 14). Trivedi and colleagues found that greater MDD symptom severity was statistically significantly associated with reduced QOL, and that socio-demographic factors such as race, education, employment, and medical insurance status, as well as general medical and depressive illness were independently associated with poorer QOL (13). Daly and colleagues further examined QOL across psychological, physical, and social domains, showing low correlations between these three domain measures, suggesting that they evaluate different and non-overlapping aspects of function (14). However, the full details of the pre-treatment QOL, the immediate and long-term impact of treatment on QOL, and the clinical significance of the aforementioned themes remain to be investigated. Moreover, studies examining what depressed patients ranked as important goals for treatment revealed that patients hope to return to 'normal' levels of functioning and QOL (15). Research seems to point to the notion that patients and clinicians seem to expect this normalization after achieving remission (15), an idea that has yet to be examined. We know very little about the proportions of patients with 'normal', i.e., close to community norm QOL scores, before and after treatment. This present analysis examines QOL at entry and exit of each of the four levels of the acute treatment phase as well as the 12-months follow-up phase of the STAR\*D study. We hypothesized that:

1. Prior to treatment, MDD patients will report statistically significant QOL deficits, defined as the minority of patients reporting 'within-normal' QOL and the majority reporting 'severely-impaired' QOL.
2. QOL will show statistically significant improvement with each treatment level, however a proportion of patients will continue to experience the aforementioned QOL deficits immediately after acute treatment.
3. After 12 months, patients who achieved MDD remission will experience higher QOL scores, perhaps close to those seen in community norms.

### **Aims of the study**

The aim of the study is to examine Quality of Life at the entry and exit of each of the four levels of the acute treatment phase as well as the 12-months follow-up phase of the STAR\*D study.

## **Material and methods**

### **Study Population**

Funded by the National Institute of Mental health (NIMH), the STAR\*D study was conducted at 18 primary care and 23 psychiatric care centers in the United States. STAR\*D enrolled 4,041 treatment-seeking outpatients aged 18–75 between 2001 and 2007, all

carrying a primary diagnosis of MDD. Full details of the study's methodology are described elsewhere (11, 12). The authors of the present study obtained an NIMH Data Use Certificate to utilize the STAR\*D Public Ver3 dataset. To be eligible for the present analysis, participants needed to have complete data for each of the outcome measures detailed below, at both entry and exit for each level of the study. Patients who were in remission at the beginning of each level were excluded. The analyzed dataset of this study contained 2,280 Level1-participants, 749 Level2-participants, 190 Level3-participants, 56 Level4-participants, and 414 participants from all levels at 12-months follow-up.

### Treatments Administered

The treatment interventions are detailed elsewhere (11, 12). Briefly, treatments were administered according to a fixed-flexible dosing schedule and modified based on each participant's response. Patients were moved to the next level if they did not achieve remission. Participants were enrolled into the following STAR\*D levels:

Level 1: Citalopram monotherapy.

Level 2: Switching to sertraline, sustained-release (SR) bupropion, extended-release (XR) venlafaxine, or Cognitive Behavioral Therapy (CBT) OR Augmenting with bupropion SR, buspirone, or CBT.

Level 3: Switching to nortriptyline or mirtazapine OR Augmenting with lithium or Triiodothyronine (T3).

Level 4: Switching to tranylcypromine OR Switching to venlafaxine XR + mirtazapine.

The study used an equipoise stratified randomized design which allowed patients a choice between several switch or augmentation strategies, within the permissible limits of the study design. This approach was adopted in lieu of complete randomization in order to mimic clinical practice (16). During the follow-up phase, patients were strongly advised to continue taking the previously effective drug(s) (17).

### Outcome Measures

QOL was assessed using the Quality of Life Enjoyment and Satisfaction Questionnaire (Q-LES-Q) (18). The Q-LES-Q is a self-report instrument that measures satisfaction and enjoyment in a series of discrete domains of functioning such as mood, social relationships, living or housing situation, and physical health. This study uses the short version, which has 16 items, each scored on a 5-point Likert scale. Summing up the results of the 14 first items, then dividing by the maximum possible score and multiplying the figure by 100 gives a total score ranging from 0 to 100, with 0 being lowest QOL score and 100 the highest. Community norm samples have a mean Q-LES-Q score of 78.3 (SD=11.3) and scores within 10% of this value, i.e., Q-LES-Q 70.47, are considered 'within-normal' QOL (1), which corresponds with the 75th percentile. Q-LES-Q scores greater than 2 SD below the community norm scores, i.e., Q-LES-Q scores 55.7, are considered 'severely-impaired' QOL (19), which corresponds with 95th percentile. The Q-LES-Q has shown moderately negative correlations with the Clinical Global Impressions–Severity of Illness scale (CGI-S) ( $r = -0.62$  for the summary scale) and the 17-item Hamilton Rating Scale for Depression (HRSD<sub>17</sub>) ( $r = -0.61$  for the summary scale). The Q-LES-Q also has strong psychometric

properties (Cronbach's  $\alpha=0.90$ , test-retest reliability  $r=0.74$ ) (18). Although STAR\*D did include the SF-12 as another QOL/Functioning instrument, a number of limitations (with the SF-36 and its abbreviated version, SF-12) precluded its use for our purpose in studying QOL, the most important of which are: the confusion/mix-up in asking patients to self report functioning level in lieu of QOL, and the equal emphasis on physical and mental components of health status (4). Therefore, we limited the analysis to using the Q-LES-Q.

MDD symptom severity was measured using the Quick Inventory of Depressive Symptomatology-Self Report (QIDS-SR) (0 =not depressed to 27=most depressed) with remission is defined as a score  $\leq 5$  (20). The QIDS-SR is highly correlated with all three versions of the widely utilized clinician-rated Hamilton Rating Scale for Depression, the Montgomery Åsberg Depression Rating Scale, and the Beck Depression Inventory, with a high internal consistency; Cronbach's  $\alpha=0.86$  (20).

### Statistical Methods

The variables were assessed and confirmed to have normal distribution. Summary values are expressed as means and standard deviations (SD) for continuous variables, and frequencies (%) for categorical variables. The paired t-test was used for comparisons between entry and exit numerical outcomes, within each level. Effect sizes were calculated for the outcomes (21), in which Cohen's  $d$  values of 0.2, 0.5, and 0.8 describe small, medium, and large effects, respectively (22). Since we calculated Cohen's  $d$  values in paired samples pre and post treatment, effect sizes were corrected for correlated designs as detailed by Dunlap et al. in 1996 using Equation 3 (23). Entry to exit comparisons of binary variables within each level and follow-up, were assessed using the exact version of the McNemar test for related proportions. The proportions of patients that scored 'within-normal' on the relevant measures were compared between remitters and non-remitters at exit, using the Chi-square test (or Fisher exact test for small sample sizes). Given the number of performed tests, we used a Bonferroni-adjusted 0.01 significance level for each test. Analyses were performed using SAS software, version 9.2 (SAS Institute Inc., Cary, NC).

## RESULTS

### Study Population Demographics

The demographic characteristics of the analyzed patient sample ( $n=2,280$ ) are shown in Table 1. At baseline, women constituted nearly two thirds of the study population, the majority of patients were Caucasian, more than one half were employed, and about one third were college graduates. The demographic characteristics of the analyzed sample were comparable to those of the whole STAR\*D sample.

### Mean Scores on Measures of Depressive Symptom Severity, and Quality of Life

STAR\*D level-by-level, pre and post-treatment QOL scores (Q-LES-Q), and depressive symptom severity (QIDS-SR), in addition to scores at entry and exit from the 12-months follow-up phase, are displayed in Table 2.

Patients in the acute treatment phase in each level made statistically significant improvements on both measures. Changes in depressive symptom severity (QIDS-SR scores) showed the following effect sizes (Cohen's  $d$ ) at the end of each level of treatment:  $d=1.05$  at Level1,  $d=0.65$  at Level2,  $d=0.42$  at Level3, and  $d=0.71$  at Level4 ( $p<0.001$  for all). Changes in QOL, as indicated by differences in pre- and post-treatment scores on the Q-LES-Q, had the following effect sizes: Level1 Cohen's  $d=0.78$  ( $p<0.001$ ), Level2  $d=0.52$  ( $p<0.001$ ), Level3  $d=0.20$  ( $p=0.002$ ), and Level4  $d=0.41$  ( $p=0.001$ ).

Interestingly, patients at 12-month follow-up showed statistically significant deterioration on both measures with effects sizes of QIDS-SR Cohen's  $d=-0.43$  ( $p<0.001$ ), and Q-LES-Q  $d=-0.38$  ( $p<0.001$ ).

It is also important to note that at baseline of Level1, the Pearson's correlation coefficient ( $r$ ) between the QIDS-SR and the Q-LES-Q is 0.74.

### Proportions of Patients with 'Within-normal' Quality of Life Scores

STAR\*D level-by-level and 12-months follow-up, entry and exit proportions of patients exhibiting 'within-normal' QOL (Q-LES-Q  $\geq 70.47$ ) are displayed in Table 3.

At entry to any level, no more than 3% of MDD patients experienced 'within-normal' QOL. Although treatment increased the number of patients achieving 'within-normal' QOL scores, the majority of patients (70.9%) scored lower than the 'within-normal' QOL range.

Nearly 46.4% of follow-up patients were in remission after 12 months of completing acute treatment. The proportions of follow-up patients experiencing 'within-normal' scores for QOL at 12 months decreased from the time of acute treatment phase completion: from 46.6% to 31.6% ( $p<0.001$ ).

### Proportions of Patients with 'Severely-Impaired' Quality of Life Scores

Level-by-level, pre- and post-treatment in addition to entry and exit follow-up percentages of patients with 'severely-impaired' QOL (two SD below community norms, i.e., Q-LES-Q  $\leq 55.7$ ) are displayed in Table 3.

QOL data, at all treatment levels, revealed that the majority ( $>80\%$ ) of MDD patients experienced 'severely-impaired' QOL at entry. The data also shows that treatment statistically significantly decreased the number of patients with 'severely-impaired' QOL at the end of each level. For instance, at the end of Level1, the percentage of patients experiencing 'severely-impaired' QOL decreased from 85.6% to 50.5% ( $p<0.001$ ). However, consistent with the above findings on 'within-normal' scores, sizable proportions of patients were still left with 'severely-impaired' QOL, ranging from 50 to 70%.

The proportions of follow-up patients experiencing 'severely-impaired' QOL showed a statistically significant increase from 28.5% at entry to follow-up, to 42.5% after 12 months ( $p<0.001$ ).

### Proportions of Remitters vs. Non-Remitters with ‘Within-Normal’ Quality of Life Scores

Remission from MDD is defined as experiencing minimal symptoms or none at all, as measured by QIDS-SR score  $\leq 5$  (20). As detailed in Table 4, remission was associated with a statistically significant increase in the proportion of patients experiencing ‘within-normal’ QOL (Q-LES-Q scores) after each level of treatment. However, despite meeting remission criteria, 30–60% of patients did not achieve ‘within-normal’ QOL scores at exit. Similarly, Table 4 shows that the proportion of patients with ‘severely-impaired’ QOL showed a statistically significant decrease, especially in remitters. Nevertheless, 9–43% of remitters still scored in the ‘severely-impaired’ QOL range.

The proportion of follow-up patients with ‘severely-impaired’ QOL or ‘within-normal’ QOL scores did not statistically significantly change after 12 months in remitted patients. In contrast, non-remitters showed a statistically significant decrease in proportions of individuals with ‘within-normal’ QOL scores (from 31.8% to 7.7%;  $p < 0.001$ ) and increased proportions of patients with ‘severely-impaired’ QOL (from 41% to 68%;  $p < 0.001$ ).

## DISCUSSION

The present study has a number of important findings: Firstly, MDD patients reported statistically significant QOL deficits, i.e., both high proportions of ‘severely-impaired’ QOL (i.e.  $>2SD$  below community norms), and low proportions of patients scoring within the community norm of QOL scores at the entry of each STAR\*D level. Secondly, treatment was associated with statistically significant improvement in QOL, although the majority of all MDD patients continue to experience lower QOL than the general population, with a low proportion of them scoring ‘within-normal’ QOL; in addition, at each level, patients who achieved remission showed greater improvements in QOL compared to their non-remitting counterparts, yet a sizable proportion of remitted MDD patients did not achieve ‘within-normal’ QOL scores. Thirdly, follow-up data show that the mean QOL scores of all patients declined after 12 months, as did the proportion of overall patients experiencing ‘within-normal’ scores; an effect that was only statistically significant in non-remitters.

With no more than 3% of STAR\*D entry patients—at any level—reporting ‘within-normal’ QOL, treating MDD poses a tremendous challenge, not only in treating depressive symptoms but also in ultimately improving QOL. Previous studies have shown that QOL is impaired in MDD and that depression severity is a major contributor to poor QOL (3, 4). It has been postulated that there is a bidirectional relationship between QOL and MDD where MDD could lead to poor QOL and vice versa, in addition to the possible negative influence of depression influence on self evaluation including rating one’s own QOL (24–26). Our study shows a strong correlation between the QIDS-SR and the Q-LES-Q of 0.74. In other analyses that examined baseline QOL in MDD data, although moderate to high correlations between depressive symptom severity and QOL were detected, regression analyses showed that the former (as measured by the QIDS-SR) accounted for only 48% of the variance in QOL (as measured by the Q-LES-Q) (4). Reduced QOL in depressed patients may be associated with problems with financial issues, family or social relationships, living situation, or physical health. Earlier pre-treatment analyses of the STAR\*D study revealed



that socio-demographically disadvantaged patients with greater general medical and depressive illness burden were at greatest risk for poor QOL (13, 14).

One of the primary objectives of the present study was to determine the extent to which observed deficits in QOL in MDD patients could be improved by treatment, and whether the progress could be maintained at 12 months. Our findings indicate that QOL shows statistical significant improvements when MDD is treated, especially in symptom severity and QOL, with the largest effect sizes observed after the first treatment trial (Level1). However, fewer than 30% of patients exiting Level1 of treatment – both remitters and non-remitters - achieved ‘within-normal’ QOL scores. Additionally, more than 50% of these same patients had ‘severely-impaired’ QOL. Low overall remission rates (e.g. 35% at Level1) may partially explain why most patients continued to experience QOL deficits following treatment.

Our findings reveal that remitted patients showed a remarkable change in the proportions achieving ‘within-normal’ QOL scores after treatment. Of note, 68% of remitted patients at the end of Level 1 treatment reported 'within normal' QOL; a proportion that is not markedly different from the proportion expected for the healthy population. This finding points out to the positive QOL gains that could be made in the early stages of treatment. More strikingly, after 12 months of follow-up, the proportion of patients experiencing ‘within-normal’ QOL scores decreased in non-remitters, a trend not observed in remitters. These findings, coupled with previous studies which had reported that patients who failed to achieve complete symptomatic remission often continued to have psychosocial impairment and were more likely to relapse into full depression (27), reinforce the notion that remission (minimal or no symptoms), as opposed to response (typically 50% reduction in severity), should be one of the primary goals of MDD treatment.

Furthermore, our results suggest that treatment should strive to achieve more than mere symptom resolution or remission. A good proportion of remitted patients still had QOL deficits after treatment. Similar deficits in remitted patients have been reported by Angermeyer and colleagues (5), who stated that remitted patients’ QOL scores remained lower than those observed in non-depressed controls, after seven months following discharge for a depressive episode hospital admission. As some remitted patients may return to a perfectly normal social life, others may experience trouble readjusting to their occupational responsibilities in the wake of their depression. These ongoing deficits imply that remitted patients could remain dissatisfied and feel incapacitated across multiple life domains—even after an otherwise clinically successful treatment regimen.

The expectation that QOL could improve spontaneously after symptom remission was not fully supported by the 12-month follow-up data analysis in this study. On the contrary, QOL suffered from statistically significant deterioration specifically in non-remitters, whereas it did not change from entry to follow-up in patients who maintained remission. The above findings are consistent with the literature on long-term follow-up of QOL in MDD (5, 6).

Evidence suggests that improving QOL is an important treatment target for patients with MDD (25). Zimmerman and colleagues examined the outcomes that patients think are

important when treating their MDD (15). Three factors were found to be better indicators of remission than the mere absence of depressive symptoms: the presence of positive mental health, such as optimism and self-confidence, a return to one's usual, normal self, and a return to normal levels of functioning at home, work, or school (15).

Taken together, the findings suggest that while clinicians should target remission as an initial goal of treatment, they need to subsequently extend their interventions to focus on the specific issues where patients continue to experience difficulty, such as QOL and its domains, notwithstanding the contributing factors highlighted above. Interventions that appear in published original research and/or literature reviews, and are postulated to improve QOL include: cognitive behavioral therapy (28), future-directed therapy (29), combined psychotherapy and pharmacotherapy (30), occupational/vocational therapy (31), dopaminergic agents (32), nutrition and nutritional supplements (33), augmentation with omega-3 (34), exercise (35), meditation and yoga (36), humor (37), massage (38), and music (39). QOL interventions could also include the treatment of possible comorbid medical and psychiatric conditions (40, 41), and treatment of sexual dysfunction (42, 43). However, randomized, controlled, large sample studies need to be conducted to confirm the above interventions' usefulness in MDD. An additional approach to improving QOL consists of identifying and compiling the items poorly rated by patients on baseline QOL measures and utilizing them to guide the creation and implementation of a personalized treatment plan containing interventions to address each impaired domain. A wraparound approach to MDD care, combining the efforts of primary care physicians, specialists, nursing staff, social workers and therapists is an option that could be considered (44). Incorporating QOL measurement and monitoring into clinical practice is becoming a vital component to personalize treatment as detailed above. Newly introduced burden of illness measures incorporating symptom severity, functioning, and QOL, such as the Individual Burden of Illness Index for Depression (IBI-D) (45), represent measurement methodologies that may provide more clinically relevant information.

In summary, increased emphasis should be placed on functional outcomes such as QOL, as important, and perhaps the ultimate, indicators of successful treatment (24–27).

### Limitations and Strengths

Our study has a number of limitations, some are related to the STAR\*D study and some are related to our own analysis. The lack of data on patients who dropped out could have potentially provided useful information about their QOL. Younger patients, African-Americans, those with lower education, and individuals with lower income were shown to be more likely to drop out of the STAR\*D study (46,47). Medical predictors of attrition included higher side effects and a higher number of Axis I comorbidities. Previous analyses showed that attrition in the first two steps of the STAR\*D study was in the vast majority of cases motivated by non-medical reasons; 92% and 90% respectively (47, 48). Attrition makes it difficult to generalize the conclusions from the sample studied. In the future, it would be important to analyze dropout data in order help us better understand the nature of these patients' struggles. The lack of a control group in the STAR\*D study, deprived us from useful comparative data. Another limitation involves the challenge of translating the



above research findings into clinical practice. Administering QOL measures, and acting on their findings, must be balanced against the time-constraining realities of modern practice, however QOL improvement is becoming an established treatment goal in many areas of medicine such as ophthalmology (49) and cardiology (50).

The reliance on self-report raises questions about magnification or minimization of ratings, however patient reported outcomes (PRO) using valid and reliable instruments, such as the ones used in STAR\*D, is a growing movement in healthcare and is widely supported by NIH PROMIS, WHO, and the FDA PRO initiatives, as well as clinicians and researchers alike. In this analysis we described QOL using both continuous and categorical approaches. A number of authors had criticized categorizing continuous variables (51, 52). We first examined continuous data to detect changes in depressive symptom severity and QOL using statistical significance parameters with effect sizes, and then we examined two categorical variables derived from QOL scores. Although one could never ascertain pre-morbid QOL, we acted on feedback from patients concerning their need for “normalization” of functional outcomes (15). Therefore, we categorized both variables ‘within-normal QOL’ and ‘severely-impaired’ QOL based on parameters identified in previously published research work (3, 19), similar to when depressive symptoms are categorized as “remission” or “response” according to a cutoff score. Another limitation concerns the fact that our study is a post hoc analysis; therefore the study findings should be considered hypothesis-generating and would need to be replicated in prospective randomized placebo-controlled clinical trials. A possible additional limitation of the study concerns the possible paradoxical impact of pharmacological interventions on QOL. Although antidepressants and other drugs are generally safe and well tolerated, the adverse effects associated with medications could negatively impact QOL and thus mitigate their otherwise positive overall effect (53). Additionally, although follow-up patients were strongly encouraged to continue their effective medications, one could not be absolutely sure that the patients completely followed this directive, especially in the absence of medication-level monitoring in this study.

Ethical considerations of clinicians making judgments about patients’ QOL to guide provision of services have long been debated in medicine (54). Moreover, administering questionnaires that might add to the emotional burden of depressed patients recognizing the magnitude of their QOL deficits, have also been debated from an ethical perspective (55).

One of the strengths of the present study is that it distinctly details pre and post-treatment and 12-months follow-up QOL data from a large population of treatment-seeking MDD patients. “Statistically significant” findings, often reported in the literature as indicated by *p* values, which do not adequately inform the reader about the relevance to the findings observed in daily practice or research settings (56), therefore we included the calculation of effect sizes as indicated by Cohen’s *d* (57). An additional strength is the fact that this population of treatment-seeking MDD patients, recruited from primary care and psychiatry specialty clinics, is representative of what clinicians see in outpatient settings. The findings can be extrapolated to everyday practice, with the one caveat that the majority of patients are Caucasians, which limits the applicability of this analysis to ethnic groups such as African-American, Hispanic, Asian, or Native-American patients. Future research effort to study QOL in minority groups is critically needed.

## CONCLUSION

The present analysis highlights the major pitfalls associated with MDD treatments that are purely symptom-focused. Such treatments can give the misleading impression that a patient has recovered, when in fact the patient continues to experience ongoing deficits in QOL. QOL did not improve further after the acute treatment phase even in remitters, and non-remitters showed a statistically significant decline at follow-up after one year. Consequently, clinicians and researchers need to move beyond the mere assessment of symptoms when treating and/or researching MDD, by incorporating QOL measurement, and by investigating specific and personalized interventions to ameliorate QOL.

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**Significant Outcomes**

- An analysis of 2,280 adult Major depressive disorder patients showed extensive and statistically significant decreased quality of life prior to treatment.
- Treatment had a statistically significant positive impact on quality of life. Nevertheless a majority of patients continue to experience quality of life deficits
- Quality of life scores declined after 12 months, as did the proportion of overall patients experiencing 'within-normal' scores.

**Limitations**

- The study lacked a placebo arm, and this post hoc analysis relied on self-reported outcomes.
- Possible paradoxical impact of pharmacological interventions on quality of life cannot be excluded.

**Table 1**

Demographic and Baseline Characteristics of the STAR\*D Analyzed Sample with Major Depressive Disorder (MDD)

<b>STAR*D Subjects with Complete QOL and Symptom Severity Data Number of Subjects=2,280</b>	
Age range	18.1 – 75.6
<b>Demographics: n (%)</b>	
	2,280 (100%)
Mean Age (SD)	42.6 (13.0)
Female	1,432 (62.8%)
Caucasian	1,846 (80.9%)
Hispanic	239 (10.5%)
College Graduate	686 (30.1%)
Employed	1301 (57.1%)
Living with Spouse/Partner	1046 (45.9%)
<b>Baseline Measures: Mean (SD)</b>	
QOL (Q-LES-Q)	41.5 (14.2)
MDD Symptom Severity (QIDS-SR)	15.4 (5.0)

**Abbreviations**

QIDS-SR = Quick Inventory of Depressive Symptomatology-Self Report

Q-LES-Q = Quality of Life measure: Quality of Life, Enjoyment, and Satisfaction Questionnaire – Short Form



**Table 2**

Mean and SD of Measures of depressive symptom severity (QIDS-SR), and quality of life (Q-LES-Q), with Mean (SD) of Change, and Effect Sizes or ES (Dunlap corrected)

Level*	N	QIDS-SR				Q-LES-Q			
		Entry Mean (SD)	Exit Mean (SD)	Change Mean (SD)	p (ES)	Entry Mean (SD)	Exit Mean (SD)	Change Mean (SD)	p (ES)
1	2,280	15.4 (4.8)	9.5 (6.5)	-6.1 (6.5)	< 0.001 (1.05)	41.5 (14.2)	56.6 (21.9)	15.1 (19.4)	< 0.001 (0.78)
2	749	14.3 (4.7)	10.5 (6.5)	-3.8 (5.8)	< 0.001 (0.65)	42.1 (15.5)	51.5 (20.1)	9.5 (17.5)	0.001 (0.52)
3	190	15.5 (4.8)	13.1 (6.3)	-2.4 (5.6)	< 0.001 (0.42)	38.8 (14.7)	42.2 (18.1)	3.4 (15.2)	0.002 (0.20)
4	56	16.4 (4.6)	12.3 (6.5)	-4.1 (6.3)	< 0.001 (0.71)	36.8 (14.3)	44.0 (19.4)	7.2 (15.6)	0.001 (0.41)
12-m. f/u	414	5.6 (3.7)	7.7 (5.7)	2.2 (5.1)	< 0.001 (0.43)	67.1 (17.8)	59.7 (20.6)	-7.4 (16.1)	< 0.001 (-0.38)

P values are considered significant at 0.01 or less (Bonferroni-adjusted), Effect sizes are Dunlap corrected for correlated designs (Dunlap et al., 1996).

\* Values compared between entry and exit at each level and between entry to follow-up and exit at 12 months of f/u.

STAR\*D Levels:

Level 1: Citalopram monotherapy

Level 2: Switching to sertraline, bupropion SR, venlafaxine XR, or CBT OR Augmenting with bupropion SR, buspirone, or CBT

Level 3: Switching to nortriptyline or mirtazapine OR Augmenting with lithium or T3

Level 4: Switching to transylpromine OR Switching to venlafaxine XR + mirtazapine

**Abbreviations:** QIDS-SR = Quick Inventory of Depressive Symptomatology-Self Report, Q-LES-Q = Quality of Life measure: Quality of Life, Enjoyment, and Satisfaction Questionnaire – Short Form

**Table 3**  
Proportions of Patients scoring at ‘Within-Normal’ and ‘Severely-Impaired’ Quality of Life at Entry and Exit from each Level and F/U.

Level*	N	‘Within-Normal QOL’			‘Severely Impaired’ QOL		
		Entry (%)	Exit (%)	McNemar Test p value	Entry (%)	Exit (%)	McNemar Test p value
1	2,280	1.7	29.1	<0.001	85.6	50.5	<0.001
2	749	2.9	19.5	<0.001	83.3	59.5	<0.001
3	190	1.6	7.9	0.008	89.5	81.1	0.023
4	56	1.8	8.9	0.220	91.1	69.6	0.004
12-m. f/u	414	46.6	31.6	<0.001	28.5	42.5	<0.001

P values are considered significant at 0.01 or less (Bonferroni-adjusted).

\* Values compared between entry and exit at each level and between entry to follow-up and exit at 12 months of f/u.

QOL ‘Within-Normal’ is defined as Q-LES-Q scores within 10% of community norms. Since community norm samples have an average Q-LES-Q of 78.3 (SD=11.3), a Q-LES-Q>=70.47 is considered ‘within-normal’ (Endicott et al., 1993, Rapaport et al., 2005, and Schechter et al., 2007). Severe Impairment in QOL is defined as Q-LES-Q scores greater than 2 SD below the community norms. Since community norm samples have an average Q-LES-Q of 78.3 (SD=11.3), a Q-LES-Q<=55.7 is considered ‘severely-impaired’ (Endicott et al., 1993, Rapaport et al., 2005, and Schechter et al., 2007).

STAR\*D Levels:

- Level 1: Citalopram monotherapy
- Level 2: Switching to sertraline, bupropion SR, venlafaxine XR, or CBT OR Augmenting with bupropion SR, buspirone, or CBT
- Level 3: Switching to nortriptyline or mirtazapine OR Augmenting with lithium or T3
- Level 4: Switching to tranylcypromine OR Switching to venlafaxine XR + mirtazapine

**Abbreviations:** Q-LES-Q = Quality of Life measure: Quality of Life, Enjoyment, and Satisfaction Questionnaire – Short Form

Table 4

Proportions of Remitters/Non-Remitters at 'Within-Normal and 'Severely Impaired' Quality of Life at Entry/Exit from each Level and Follow-up.

Level	Remitters				Non-Remitters				Difference at Exit
	N	'Within-Normal' QOL Entry (%)	'Within-Normal' QOL Exit (%)	McNemar Test p value	N	'Within-Normal' QOL Entry (%)	'Within-Normal' QOL Exit (%)	McNemar Test p value	
1	812	3.0	68.0	<0.001	1,468	1.0	7.6	<0.001	<0.001
2	208	5.8	52.4	<0.001	541	1.8	6.8	<0.001	<0.001
3	30	0	40.0	<0.001	160	1.9	1.9	n/a	<0.001 *
4	8	0	25.0	0.500	48	2.1	6.3	0.630	0.144 *
12-mo. f/u	193	63.4	58.8	0.260	221	31.8	7.7	<0.001	<0.001
Level	Remitters				Non-Remitters				Difference at Exit
	N	'Severely-Impaired' QOL Base (%)	'Severely-Impaired' QOL Exit (%)	McNemar Test p value	N	'Severely-Impaired' QOL Base (%)	'Severely-Impaired' QOL Exit (%)	McNemar Test p value	
1	812	79.3	9.0	<0.001	1,468	89.0	73.4	<0.001	<0.001
2	208	74.5	16.3	<0.001	541	86.7	76.2	<0.001	<0.001
3	30	83.3	43.3	0.004	160	90.6	88.1	0.570	<0.001 *
4	8	87.5	25	0.063	48	91.7	77.1	0.065	0.007 *
12-mo. f/u	193	14.4	13.4	0.860	221	40.9	68.2	<0.001	<0.001

P values are considered significant at 0.01 or less (Bonferroni-adjusted).

\* Fisher exact test used due to small sample size

QOL 'Within-Normal' is defined as Q-LES-Q scores within 10% of community norms. Since community norm samples have an average Q-LES-Q of 78.3 (SD=11.3), a Q-LES-Q>=70.47 is considered 'within-normal' (Endicott et al., 1993, Rapaport et al., 2005, and Schechter et al., 2007). Severe Impairment in QOL is defined as Q-LES-Q scores greater than 2 SD below the community norms. Since community norm samples have an average Q-LES-Q of 78.3 (SD=11.3), a Q-LES-Q<=55.7 is considered 'severely-impaired' (Endicott et al., 1993, Rapaport et al., 2005, and Schechter et al., 2007).

STAR\*D Levels:

Level 1: Citalopram monotherapy

Level 2: Switching to sertraline, bupropion SR, venlafaxine XR, or CBT OR Augmenting with bupropion SR, buspirone, or CBT

Level 3: Switching to nortriptyline or mirtazapine OR Augmenting with lithium or T3

Level 4: Switching to transylpromine OR Switching to venlafaxine XR + mirtazapine

**Abbreviations:** f/u = Follow-up; Q-LES-Q = Quality of Life measure: Quality of Life, Enjoyment, and Satisfaction Questionnaire – Short Form



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## Impact of depression on quality-adjusted life expectancy (QALE) directly as well as indirectly through suicide

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### Abstract

**Purpose**—To estimate quality-adjusted life expectancy (QALE) loss among US adults due to depression and QALE losses associated with the increased risk of suicide attributable to depression.

**Method**—We ascertained depressive symptoms using the eight-item Patient Health Questionnaire (PHQ-8) on the 2006, 2008, and 2010 Behavioral Risk Factor Surveillance System (BRFSS) surveys. We estimated health-related quality of life (HRQOL) scores from BRFSS data ( $n = 276,442$ ) and constructed life tables from US Compressed Mortality Files to calculate QALE by depression status. QALE loss due to depression is the difference in QALE between depressed and non-depressed adults. QALE loss associated with suicide deaths is the difference between QALE from only those deaths that did not have suicide recorded on the death certificate and QALE from all deaths including those with a suicide recorded on the death certificate.

**Results**—At age 18, QALE was 28.0 more years for depressed adults and 56.8 more years for non-depressed adults, a 28.9-year QALE loss due to depression. For depressed adults, only 0.41 years of QALE loss resulted from deaths by suicide, and only 0.26 years of this loss could be attributed to depression.

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**Conflict of interest** The authors declare that they have no conflict of interest.

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**Conclusion**—Depression symptoms lead to a significant burden of disease from both mortality and morbidity as assessed by QALE loss. The 28.9-year QALE loss at age 18 associated with depression markedly exceeds estimates reported elsewhere for stroke (12.4-year loss), heart disease (10.3-year loss), diabetes mellitus (11.1-year loss), hypertension (6.3-year loss), asthma (7.0-year loss), smoking (11.0-year loss), and physical inactivity (8.0-year loss).

### Keywords

Depression; Suicide; Health-related quality of life (HRQOL); Quality-adjusted life expectancy (QALE); Life expectancy

### Introduction

Depression can include several symptoms associated with cognition, negative affect, anxiety, and somatization and can present in individuals in various ways including brief symptoms that often resolve on their own or frequently recurring symptoms that can lead to chronic debilitating mental illness [1]. The prevalence for one kind of chronic depression, major depression, is relatively consistent across large nationally representative surveys: 6.7 % in the past 12 months and 16.6 % over a lifetime [2]. When symptoms that may indicate depression occur within the past 2 weeks, the prevalence of major depression ranges from 3.0 to 3.5 % [3]. When any such symptoms occur within the last 2 weeks, including major depression as well as episodic depression, the prevalence of depression ranges from 7 to 9 % [3].

Depression is a risk factor for many chronic conditions such as cardiovascular diseases and neurological disorders and is associated with risky behaviors such as drug, tobacco, and alcohol abuse [4–7]. Depression is also associated with poor health-related quality of life (HRQOL) and increases the number of years of life lived with disabilities [8, 9]. Depression can be life threatening and has been associated with excess mortality and substantially lower life expectancy [10, 11]. In a longitudinal study of elderly individuals followed up to 48 months, individuals diagnosed with major depression were twice as likely to die as those without depression [12]. Although this increased mortality risk may be indirectly caused by chronic conditions including diabetes and obesity and risky behaviors such as alcohol and drug use, depression alone is likely to be directly responsible through suicide for a proportion of its increased mortality risk [13, 14]. Most individuals who commit suicide have psychiatric illnesses [15]. In a systematic review of risk factors associated with suicide among depressed individuals, many of the most important risk factors included symptoms and conditions associated with depression such as more severe depression (OR = 2.20), hopelessness (2.20), anxiety (OR = 1.59), and the misuse of alcohol and drugs (OR = 2.17) [16]. In one longitudinal study, 8 % of individuals with a major depressive disorder attempted suicide over an 18-month period [17]. However, these studies have many methodological weaknesses that include less representative samples of older patients in clinical settings with multiple chronic conditions, especially those with serious mental illness [12, 17]. Estimates are lacking of the long-term health consequences and losses among representative samples of individuals with depression compared to individuals without depression across their entire life spans as well as comparisons of health losses for

those with depression compared to those with other chronic conditions. The magnitude of the impact of depression on suicide and the number of years of life lost due to the increased risk of suicide among those with depression are also unknown [13, 17].

Much of the lifetime burden of disease of depression is associated with the early age of onset of depression. In the National Comorbidity Survey (NCS), the median ages of onset for major depression, dysthymia, and bipolar disorders were 32, 31, and 25 years, respectively [2, 18], significantly younger than the ages of onset for most other chronic conditions such as heart disease and diabetes. Several different methods are available to assess the lifetime burden of disease for a condition such as the years lived with a disability (YLDs), disability-adjusted life years (DALYs), and quality-adjusted life years (QALYs) [19]. In the Global Burden of Disease Study that estimated YLDs worldwide for all infectious and chronic disease conditions, depression was the second leading cause of YLDs [8, 9]. Furthermore, when major depression is combined with other psychiatric conditions that include significant depressive symptoms (e.g., dysthymia and bipolar disorder), this combined estimate for depression is the leading health condition worldwide in terms of DALYs and YLDs [20].

QALYs and an associated measure, quality-adjusted life expectancy (QALE), take into account both the years of life lost and the relative severity of disease, making it possible to quantify the total health losses of both non-fatal and fatal mortality outcomes for affected patients or a target population [19, 21–23]. The burden of disease for non-fatal outcomes for QALYs and QALEs use preference-based HRQOL measures to assess both how a person perceives her/his health and how much that person values one health state versus another state. Preference-based HRQOL measures capture respondents' health states using a summary score anchored at 0 (dead) and 1 (perfect health) [19]. Thus, 1 year of life lived at a health state valued at 0.5 is assessed as 0.5 quality-adjusted life years (QALYs), the same as only a half year of life lived in perfect health [21, 22]. QALE at a certain age is defined and calculated as the average number of QALYs throughout the remainder of expected life [21, 22]. One advantage of QALE over DALY or YLD is that QALE uses the health state value to weight life years, so that calculating QALE loss due to depression could be useful for evaluating the economic cost of depression and for analyzing the cost-effectiveness of treatments and interventions [19, 21–23].

The first aim of this study is to estimate QALE losses due to depression for US adults and to compare such losses due to depression with previously reported losses due to five other common chronic conditions (stroke, heart disease, diabetes mellitus, hypertension, and asthma) and two significantly harmful health behaviors, smoking and physical inactivity. The second aim of this study is to estimate QALE loss due to increased risk of suicide death attributable to depression. This is the first study we are aware of to estimate QALE losses due to depression as well as losses due to increased risk of suicide death attributable to depression.

## Materials and methods

We calculated QALE loss due to depression in four steps. First, using data from the Behavioral Risk Factor Surveillance System (BRFSS), we calculated HRQOL values as a function of age and depression outcome. Second, we estimated age-specific mortality rates stratified by depression status using the Compressed Mortality File. Third, using the estimated age-specific mortality rates from step 2, we constructed life tables to calculate life expectancy as a function of depression and estimate years of life lost due to depression. Fourth, we calculated QALE by combining estimated HRQOL values from step 1 and life tables from step 3. We calculated QALE by depression outcome and estimated QALE loss due to depression.

## Sample

The Behavioral Risk Factor Surveillance System (BRFSS), a state-based annual health survey of non-institutionalized civilian US residents, uses random-digit-dialed telephone survey methods to ascertain sociodemographic characteristics, behavioral risk factors, and health outcomes in a population-based random sample of adults 18 years or older [24–26].

BRFSS has included the eight-item Patient Health Questionnaire (PHQ-8) depression scale as an optional module to estimate depressive symptoms and depression status during 2006, 2008, and 2010 [27]. The PHQ-8 is a valid diagnostic and severity measure for depressive disorders in large clinical studies [28] and for estimating depression prevalence [3, 27, 29]. Thirty-six States and the District of Columbia administered the PHQ-8 at least once during these three survey years, yielding a total sample size of 276,442. Current depression in this study is defined as PHQ-8 index  $\geq 10$  [27]. The PHQ-8 score of  $\geq 10$  has 88 % sensitivity and 88 % specificity for major depression and represents clinically significant depressive symptoms [4, 28, 30].

The BRFSS includes information on respondent sociodemographic characteristics, risky behaviors, and certain diseases related to current depression. We included these variables in analyses of the depression outcome to assess potential associations with these variables. The sociodemographic characteristics analyzed in this study included age, sex, race/ethnicity, marital status, and educational achievement. The risky behaviors included were weight differences from normal weight based on the body mass index (BMI)—underweight (BMI < 18.5 kg/m<sup>2</sup>), overweight (25  $\leq$  BMI < 30 kg/m<sup>2</sup>), and obese (BMI  $\geq$  30.0 kg/m<sup>2</sup>); current cigarette smoking (respondents who report both having smoked at least 100 cigarettes in their lifetimes and currently smoke); physical inactivity (respondents who report doing no physical activity or exercise during the past 30 days other than that for their regular job); and heavy alcohol drinking (men who report having three or more alcoholic drinks per day and women who report having two or more alcoholic drinks per day). We also assessed associations with cardiovascular-related diseases [had either a heart attack (myocardial infarction), angina or coronary heart disease, or a stroke].



### Non-fatal health loss due to depression

Non-fatal health loss due to depression was defined and calculated as the decrease in HRQOL scores for those with current depression compared to those without current depression. The BRFSS questionnaire includes a set of four HRQOL questions that asks respondents to report their general health status (excellent, very good, good, fair, or poor) and the numbers of physically unhealthy days, mentally unhealthy days, and days with activity limitation during the past 30 days [31]. We applied a published mapping algorithm to obtain values of EuroQol Group's EQ-5D index, a preference-based HRQOL measurement, from the four BRFSS HRQOL items [32, 33]. This algorithm provides valid estimates of EQ-5D scores with a relative bias of less than 1 % of the actual observed EQ-5D [33].

We calculated mean EQ-5D, standardized to the year 2010 US population, for those with current depression and those without current depression, and then estimated the difference in age-adjusted EQ-5D between those with current depression and those without current depression as the non-fatal health loss due to depression.

### Fatal health loss due to depression

Fatal health loss due to depression was defined as years of life lost due to depression and was operationalized as the difference in life expectancy between those with current depression and those without current depression [34]. Life expectancy at a given age is the expected/average number of years of life remaining starting at that age and is calculated from age-specific mortality rates [35, 36]. The National Center for Health Statistics compiles death data for the US population from death certificates and makes these data available to the public in the Compressed Mortality File at <http://wonder.cdc.gov>. The US Census Bureau provides annual population estimates (accessible at [www.census.gov/popest/states/asrh/](http://www.census.gov/popest/states/asrh/)). Both sets of data include age, gender, and other basic demographics, and can be used to estimate age-specific mortality rates for the US population overall, by sex, and by some race/ethnicity subgroups.

Because age-specific mortality rates stratified by depression status are not available, these rates were estimated from three variables—age-specific mortality rates of total population, the proportion of the population with depression, and the hazard ratio of death for those with depression relative to those without depression [37]. We estimated the proportion of the population with depression from the BRFSS and the hazard ratios from the 1999–2004 National Health and Nutrition Examination Survey (NHANES) data as linked to the National Death Index through December 31, 2006 ([http://www.cdc.gov/nchs/data\\_access/data\\_linkage/mortality/nhanes\\_99\\_04\\_linkage.htm](http://www.cdc.gov/nchs/data_access/data_linkage/mortality/nhanes_99_04_linkage.htm)).

### QALE loss due to depression

Like life expectancy, quality-adjusted life expectancy (QALE) at a certain age is the expected/average number of quality-adjusted life years (QALYs) remaining starting at that age and is calculated from age-specific mortality rates and corresponding average HRQOL scores [23, 36]. We constructed life tables to calculate life expectancy and QALE using the age-specific mortality rates and EQ-5D scores. For each year age interval (18–24, 25–34,...,



85 +), we obtained the mortality rates (per year per person) by dividing the numbers of deaths in that age interval by the number of persons in that age interval in the population. We assumed a constant probability of death during each age interval and could thus obtain estimated years of life within the interval [35, 36]. We calculated the QALYs during each age interval by multiplying the life-years within an interval by the corresponding mean EQ-5D value. Life expectancy and QALE for those at a certain age (such as 18 years old) are the average life years and QALYs starting from this age to the last age interval, respectively.

We used the estimated age-specific mortality rates and EQ-5D scores, stratified by depression status, to construct depression-specific life tables and to calculate QALE by respondents' depression status. Similar to years of life lost due to depression, QALE loss due to depression was defined and estimated as the difference in QALE between those with current depression and those without current depression [37, 38].

### **QALE loss due to increased risk of suicide death**

Suicide deaths are a subset of deaths from all causes. Suicide-associated QALE loss is defined as the impact on QALE due to additional deaths through suicide. This does not include losses due to non-fatal suicide attempts. We calculated this loss as the difference between the QALE from using only those deaths that did not have suicide recorded on the death certificate and the QALE from using all deaths including those with a suicide recorded. Because the risk of suicide is higher among those with depression than among those without depression, we estimated the additional QALE loss due to this increased risk of suicide death attributable to depression as the difference in the suicide-associated QALE loss between those with and those without depression.

### **Ethics**

This analysis used de-identified data produced by federal agencies in the public domain. Data were downloaded from the Centers for Disease Control and Prevention website (<ftp://cdc.gov/pub>).

### **Results**

We first report our descriptive results (Table 1). Approximately, 9.1 % of US adults were currently depressed based on responses to the PHQ-8. The prevalence of current depression was higher among adults 18–64 years old than older adults. After age adjustment, the prevalence of depression was statistically associated with sex, race/ethnicity, marital status, and education. Specifically, the prevalence of depression was higher among women than men; black non-Hispanics than other race/ethnicity groups; divorced, separated, or never married adults than married, widowed, or unmarried cohabiting adults; and adults with less education than those with more education. Current depression was also more common among those who were underweight or obese, current cigarette smokers, physically inactive, and heavy alcohol drinkers. Those who had cardiovascular diseases were more than twice (20.1 %) as likely to be currently depressed as those who did not have cardiovascular

disease (8.0 %). Nearly half (45.6 %) of adults who reported “poor” general health and 22.1 % of adults who reported “fair” general health were currently depressed.

We also observed gender differences in the magnitude of associations between some of these predictors and current depression. For example, compared to women with depression, men with depression were more likely to have cardiovascular diseases (age-adjusted OR = 1.6), to be heavy drinkers (OR = 2.1), to be current smokers (OR = 1.3), and to be divorced, separated, or never married (OR = 1.2).

We now report our analytic results (Tables 2, 3, 4). For those with depression, the age-adjusted EQ-5D index was 0.598, 0.307 points (34 %) lower than those without depression (0.905) (Table 2). Across subgroups defined by age, sex, race/ethnicity, and simultaneously by race and sex, those who were depressed had consistently lower EQ-5D scores than those who were not depressed. This adverse impact of depression on the EQ-5D index was significantly larger for those 65 years old or older (0.509 points lower) than those 18–44 years old (0.213 points lower) or those 45–64 years old (0.413 points lower); larger for men (0.327 points lower) than women (0.304 points lower); and larger for white non-Hispanics (0.337 points lower) than black non-Hispanics (0.266 points lower) and Hispanics (0.229 points lower).

The life expectancy at age 18 years was 47.3 more years for those with depression and 63.7 more years for those without depression. This 16.4-year (26 %) decrease represents the years of life lost due to depression, starting at age 18. The loss in life expectancy at age 18 for men with depression was 18.2 years, significantly more than the 15.3 years of life lost for women with depression ( $p < 0.0001$ ). Although the decreases in EQ-5D index were larger for white non-Hispanics than for other groups, the losses in life expectancy due to depression were significantly less for white non-Hispanics (16.1 years) than for black non-Hispanics (18.5 years) and for Hispanics (18.0 years).

The lower EQ-5D and life expectancy among those with depression yield a significantly lower QALE among those with depression (Table 3). The QALE for an 18-year-old with depression, for example, was 28.0 years, 28.9 years less than that of an 18-year-old without depression (56.8 years). This represents a decrease of QALE by more than half (51 %) for those with depression. Although QALE declined with age, depression-associated QALE losses were significant at all ages. For example, an 85-year-old person with depression had a significantly lower QALE (0.9 year) than an 85-year-old person without depression (6.9 years), a 6.0-year loss in QALE. The depression-associated QALE loss at age 18 was significantly larger among men (29.6-year loss) than among women (28.6-year loss) and larger among white non-Hispanics (29.3-year loss) than among black non-Hispanics (26.8 years) and among Hispanics (26.4-year loss), though this difference between white non-Hispanics and Hispanics was not statistically significant ( $p = 0.1$ ).

The second aim of this study estimated suicide-associated QALE loss (Table 4). For those with depression, the calculated QALE at age 18 using non-suicide mortality rates was 28.38 years, 0.41 years more than that using mortality rates including suicides (27.97 years). Thus, death by suicide contributed 0.41 years of QALE loss for those with depression. Similarly,

death by suicide contributed only 0.15 years of QALE loss for those without depression. This 0.26-year difference ( $0.26 = 0.41 - 0.15$ ) was the additional QALE loss associated with the increased risk for suicide among those with depression. Men lost more QALE to suicide death than women did, both for those with depression and those without depression. The additional QALE loss for men with depression due to their increased risk of death through suicide was 0.55 years, more than threefold that of the 0.14-year additional loss for women with depression.

Finally, we conducted a sensitivity analysis to examine the impact of suicide misclassification within death certificates on the QALE loss due to suicide. We included all unknown accident deaths as suicide deaths (i.e., new suicides = recorded suicides + unknown accident deaths) and recalculated the QALE loss due to suicide. The new calculated value of the additional QALE loss associated with the increased risk for suicide among depressed adults increased from 0.26 years to 0.29 years of QALE loss.

## Discussion

These analyses confirmed previous studies suggesting large adverse impacts of depression on both fatal and non-fatal outcomes [4, 13, 39]. The estimated burden of disease for depression for depressed individuals during their entire life span starting at age 18 was 28.9 years of QALE loss, a loss of more than half their QALE at this age. This result is consistent with previous studies that have shown a dramatic decrease in life expectancy for those with serious mental illnesses [40, 41]. This 28.9-year loss in QALE also markedly exceeds that of other chronic conditions such as stroke (12.4-year loss), heart disease (10.3-year loss), diabetes mellitus (11.1-year loss), hypertension (6.3-year loss), and asthma (7.0-year loss), and the risk factors such as smoking (11.0-year loss) and physical inactivity (8.0-year loss) reported previously (Fig. 1) [22, 37, 42]. This QALE loss also mirrors other studies concluding that depression is the top health condition worldwide in terms of disability-adjusted life years (DALYs) [20]. At least three reasons may explain this excessive QALE loss. First, the non-fatal health losses due to depression appear significantly larger than the loss due to each of the other chronic conditions mentioned previously. Major depressive disorder contributed 917 years lived with a disability (YLDs) per 100,000 persons annually, more than those of these five other chronic conditions mentioned above combined (821 YLDs per 100,000) [9]. In our study, depression decreased the EQ-5D index by 0.307 points, equivalent to a decrease in the EQ-5D index from having no chronic conditions to having between five and six chronic conditions [43] and significantly more than the 0.07–0.16 point decrease associated with any of the five other conditions and the two risky behaviors [22, 37, 42]. Second, depression affected mortality and life expectancy more than the other conditions. People with serious mental illness, which includes clinical depression, died an average of 25 years sooner than those in the general population [44]. In this study, depression decreased life expectancy at age 18 by 16.4 years, significantly more than that of the other five chronic conditions [22] and two risky behaviors [37, 42], which ranged from 3.1 years (hypertension) to 9.8 years (stroke). Third, much of the lifetime burden of disease associated with depression is based on its early age of onset. The median ages of onset for major depression (32 years), dysthymia (31 years), and bipolar disorders (25 years) are significantly younger than those for most other chronic conditions such as heart disease and

diabetes mellitus [2]. For example, about 75 % of heart disease and 84 % of stroke occur first after age 55 [22]. In this study, the depression prevalence was significantly higher among younger persons (9.8 % for those < 65 years) than older persons (5.3 % for those ≥ 65 years).

Although age-adjusted depression prevalence rates in women exceeded those in men, the QALE losses associated with depression were one year more in men than in women. This difference in QALE losses between men and women resulted from the difference in the impacts on both fatal and nonfatal outcomes. Men lost significantly more years of life and experienced larger EQ-5D losses to depression than women. Compared to women with depression, men with depression were more likely to have cardiovascular diseases, to be heavy drinkers, to be current smokers, and to be divorced, separated, or never married. All of these factors are associated with poor health outcomes. Depression also has a much large impact on mortality among men than women [13, 45, 46]. Among three race/ ethnicity subgroups in our study, depression decreased the EQ-5D index more but decreased life expectancy less in white non-Hispanics than in black non-Hispanics and Hispanics, though the combined QALE loss among white non-Hispanics (28.6-year loss) significantly exceeded that among black non-Hispanics (25.8-year loss).

Our descriptive analyses of depression confirmed previous studies of associations between depression and some sociodemographic characteristics, risky behaviors, and diseases [4–7, 13, 39]. Although these variables are potential confounders for the decreased QALE among depressed individuals, our QALE estimates were not adjusted for these factors. Therefore, the term “QALE loss due to depression” does not suggest a causal relationship. However, our estimated QALE loss due to depression markedly exceeds that of diseases associated with depression, such as heart diseases and stroke, and risky behaviors, such as smoking and physical inactivity [22, 37, 42]. In addition, our study used similar methods to these previous studies and is consistent with currently accepted methods in the literature. These findings strongly suggest that depression contributes lower QALE among individuals with depression independent of these diseases and risk factors.

Depression may be directly related to the increased risk of death through suicide [13, 14] because a large proportion of persons who committed suicide had pre-existing depression [1, 47]. Nonetheless, in this study, suicide contributed very little to QALE loss for both those with depression (0.41 years) and those without depression (0.15 years). Only 0.26 years of additional QALE losses for those with depression could be attributed to their increased risk of suicide. This 0.26 years of QALE loss was much smaller than the nearly 30 years of overall QALE loss due to depression: Only 0.9 % (1.8 % for men and 0.5 % for women) of the depression-associated QALE loss was due to the increased risk of suicide among those with depression. This most likely results from the fact that, although many who die from suicide suffer from mental disorders [48], almost all of those individuals diagnosed with a mental disorder including those with clinical depression do not die directly from suicide but from other causes [3, 13, 49]. Only 1.4 % (2.3 % for men and 0.58 % for women) of all deaths among US adults had an underlying cause of suicide, even though suicide is the second leading cause of death among those aged 15–24 years [1, 50]. Related to this, depression usually is associated with inactivity, lethargy, and a general decline in

health practices and self-care which puts those with depression at higher risk for other chronic conditions [47]. Because the Compressed Mortality File, compiled from death certificates, might underreport suicides and misclassify some suicide deaths as unknown deaths from injuries [51, 52], this study may have underestimated the impact of suicide on QALE loss. However, our sensitivity analysis showed that even attributing all unknown deaths from injuries as suicide deaths increased the estimated additional QALE loss associated with the increased risk for suicide among those with depression only 0.03 years, from 0.26 years to 0.29 years.

This study has several weaknesses. First, the PHQ-8 is not a clinical diagnostic tool for diagnosing depression but has been used primarily as a screening instrument for estimating the prevalence of depression in the general population. This would tend to reduce the accuracy and the reliability of the population estimates relative to a clinical diagnosis or interview. Second, the reporting of depressive symptoms might show mode effects that may have affected our estimates; individuals administered face-to-face interviews tend to report better health (social desirability effects) than those interviewed by telephone [3, 53]. The estimated prevalence of current depression using the BRFSS, a telephone survey, was higher (9.1 %) than the estimates using the NHANES, an in-person interview (6.8 %) [3]. However, such a higher estimated prevalence for depression would have resulted in a relatively small change in the estimated depression-associated QALE loss. For example, if we had used the estimated depression prevalence from the NHANES (6.8 % overall), the estimated QALE loss due to depression would be 28.6 years, only 0.23 year less than the 28.9 years of the estimated QALE loss based on the estimated 9.1 % overall depression prevalence from the BRFSS. Third, the BRFSS data are collected via telephone interviews using a random-digit-dialed methodology that most likely underestimates the prevalence of depression because the study population includes only non-institutionalized household members. However, our analysis demonstrates that underestimating depression prevalence would have a small effect on the estimation of QALE loss due to depression. Fourth, our estimated hazard ratios from the NHANES linked mortality data exceed others reported in the literature [12, 45], and using larger estimates of these hazard ratios would overestimate depression-associated QALE losses. If we had used the smaller estimated hazard ratio by Sullivan et al. [12] and Zheng et al. [45], the estimated QALE losses would be 26.2 years (28.1 years for men and 25.0 years for women). However, such estimates were not statistically significantly different from the estimated QALE losses in this study. Fifth, this study relies on the BRFSS's unhealthy days questions to estimate preference-based HRQOL scores indirectly rather than on direct measurements of these scores. Therefore, our estimates of QALE loss are likely to be smaller than the true values due to "regression to the mean" [32–37]. One study estimated the bias of estimated QALE loss using the estimated EQ-5D scores and found that this bias was less than 2.5 % of that using the actual EQ-5D questions [36]. Finally, not all the US states used the PHQ-8 questionnaire. Thus, if the prevalence of depression in the states using this questionnaire differed from that in the states not using this questionnaire, these results may not be fully generalizable to the entire US population. However, our analysis above on the small effects of differences in estimated depression prevalence on QALE loss due to depression may mitigate this lack of generalizability.

This study is the first we know of to estimate burden of disease for depression by comparing the QALE for currently depressed persons to that for non-depressed persons. QALE is a single index that encompasses both depression-related fatal and nonfatal outcomes. Therefore, our results are particularly useful in directly comparing the burdens of disease for depression to the burdens of disease for other chronic conditions and risky behaviors and for estimating the economic costs of depression among U.S adults [19–23]. The overall burden of depression was at least twice as large as the burdens of some common chronic conditions such as stroke, heart disease, diabetes mellitus, hypertension, and asthma and of the risk factor of smoking. This information could be useful to local and state authorities when setting health priorities and when dealing with mental problems in the general adult population [54, 55]. These results will also likely to motivate the development of improved prevention efforts and strategies for individuals at risk for depression and suicide [56–58].

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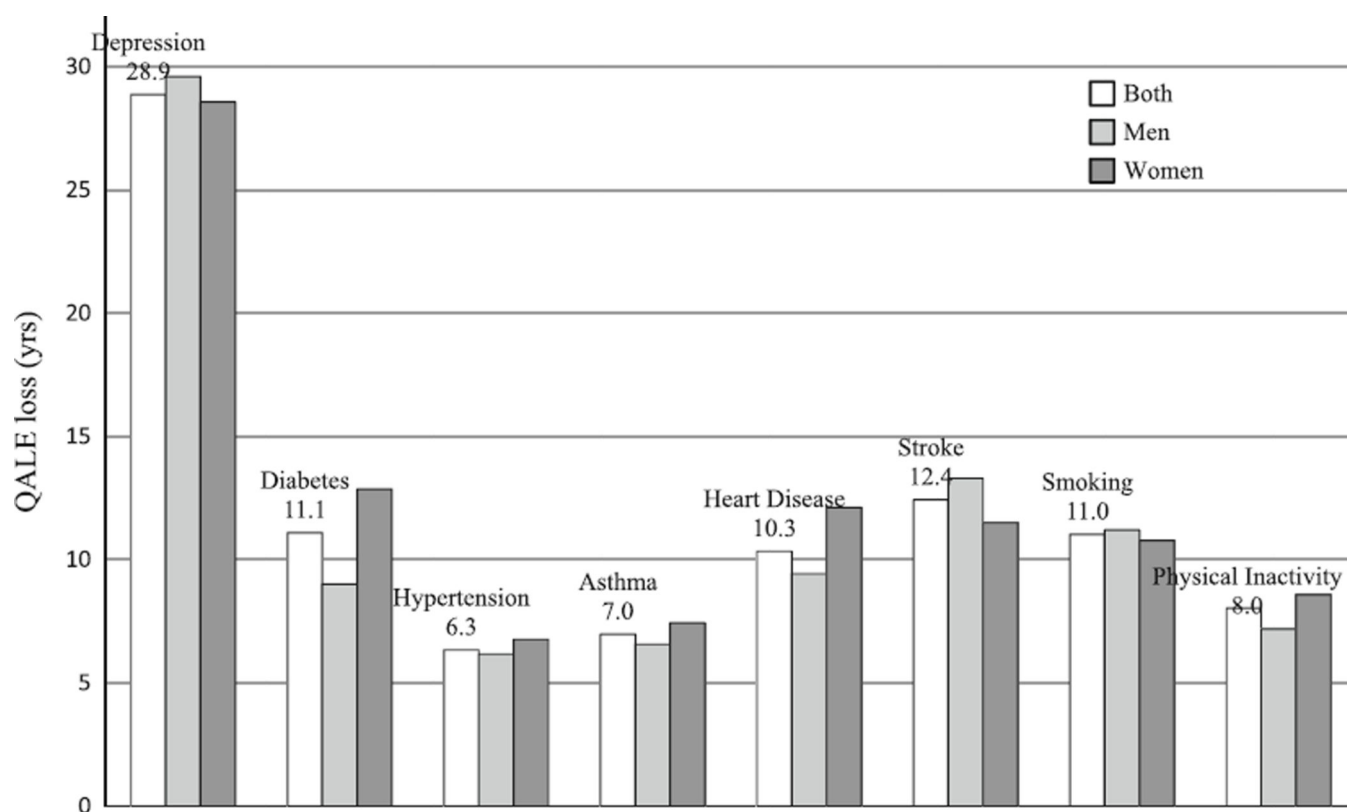
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**Fig. 1.**

Comparison of quality-adjusted life expectancy (QALE) losses due to depression, diabetes mellitus [22], hypertension [22], asthma [22], heart disease [22], stroke [22], smoking [37], and physical inactivity [42]

**Table 1**

Proportions of Current Depression among US adults by various characteristics

Characteristics	Proportion of current depression		
	<i>N</i>	Percentage <sup>a</sup>	SE (%)
All	276,442	9.1	0.13
Age			
18–44	85,974	9.6	0.21
45–64	116,716	10.0	0.20
65+	73,752	5.3	0.17
Sex			
Men	105,354	7.1	0.44
Women	171,080	11.0	0.44
Race/ethnicity			
White non-Hispanics	217,215	8.6	0.43
Black non-Hispanics	26,234	11.8	0.54
Hispanics	14,505	9.4	0.65
Others	16,526	8.7	0.65
Marital status			
Married/widowed/unmarried couples	196,679	7.2	0.44
Divorced/separated/never married	79,057	13.5	0.46
Education			
<High School	25,306	17.2	0.73
High school/some college	158,346	10.1	0.44
College graduate	92,485	4.6	0.41
Body mass index (BMI) category, (kg/m <sup>2</sup> )			
<18.5 (underweight)	4,476	13.4	1.23
18.5 to <25 (normal weight)	93,014	7.4	0.45
25 to <30 (overweight)	96,844	7.6	0.45
30 (obese)	72,421	13.2	0.48
Current smoking			
Yes	50,206	17.9	0.54
No	225,337	6.9	0.41
Physical activity			
Yes	207,032	6.6	0.41
No	69,215	17.1	0.56
Heavy alcohol drinking			
Yes	13,443	12.6	0.85
No	258,662	8.9	0.42
Cardiovascular diseases			
Yes	30,246	20.1	0.75
No	244,031	8.0	0.43

Characteristics	Proportion of current depression		
	<i>N</i>	Percentage <sup>a</sup>	SE (%)
Self-rated general health			
Excellent	52,535	2.2	0.43
Very Good	90,222	4.1	0.42
Good	83,350	9.5	0.53
Fair	34,696	22.1	0.72
Poor	14,869	45.6	1.06

*SE* standard error of estimate

<sup>a</sup>Weighted proportions of depression, for subgroups except age group itself, proportions were adjusted by age

Table 2

Impact of depression on EQ-5D scores and life expectancy (LE)

Characteristics	Not depression		Depression		Difference		Not depression		Depression		Difference	
	HRQOL <sup>a</sup>	SE	HRQOL <sup>a</sup>	SE	Loss <sup>b</sup>	SE	LE at age 18 <sup>c</sup>	SE	LE at age 18 <sup>d</sup>	SE	LE Loss at age 18 <sup>d</sup>	SE
All	0.905	0.001	0.598	0.005	0.307	0.005	63.7	0.05	47.3	0.05	16.4	0.06
By age												
18–44	0.934	0.001	0.721	0.006	0.213	0.006	63.7	0.05	47.3	0.05	16.4	0.06
45–64	0.892	0.001	0.479	0.008	0.413	0.008	38.0	0.05	24.0	0.04	14.0	0.06
65+	0.838	0.002	0.330	0.013	0.509	0.014	20.8	0.05	10.5	0.03	10.3	0.05
By sex												
Men	0.912	0.002	0.585	0.009	0.327	0.010	61.2	0.08	43.0	0.07	18.2	0.10
Women	0.899	0.003	0.595	0.006	0.304	0.006	66.1	0.08	50.8	0.12	15.3	0.17
By race/ethnicity												
White non-Hispanics	0.910	0.003	0.572	0.006	0.337	0.007	63.5	0.05	47.4	0.05	16.1	0.06
Black non-Hispanics	0.894	0.003	0.627	0.011	0.266	0.011	61.1	0.22	42.6	0.10	18.5	0.21
Hispanics	0.890	0.003	0.661	0.015	0.229	0.015	69.2	0.49	51.2	0.18	18.0	0.46
By sex and race/ethnicity												
White non-Hispanic men	0.917	0.003	0.571	0.010	0.346	0.011	61.1	0.08	43.2	0.07	17.9	0.10
White non-Hispanic women	0.903	0.003	0.573	0.007	0.330	0.008	65.8	0.08	50.8	0.12	15.0	0.17
Black non-Hispanic men	0.898	0.002	0.637	0.024	0.261	0.024	57.4	0.27	37.5	0.21	19.9	0.25
Black non-Hispanic women	0.890	0.003	0.623	0.011	0.268	0.011	64.5	0.39	46.6	0.25	18.0	0.52
Hispanic men	0.899	0.004	0.661	0.030	0.238	0.030	66.7	0.60	46.6	0.32	20.1	0.55
Hispanic women	0.882	0.004	0.662	0.015	0.220	0.016	71.7	0.89	54.8	0.52	16.9	1.10

SE standard error of estimate

<sup>a</sup> EQ-5D index, for subgroups except age group itself, age-adjusted EQ-5D index<sup>b</sup> Decrease in EQ-5D index for those with depression<sup>c</sup> Life expectancy at age 18 years. For the three ages, life expectancy at age 18, 45, and 65 years, respectively<sup>d</sup> Life expectancy loss due to depression at age 18 years. For the three ages, life expectancy loss at age 18, 45, and 65 years, respectively

**Table 3**

Impact of depression on quality-adjusted life expectancy (QALE)

Characteristics	Not depression		Depression		Difference	
	QALE at age 18 <sup>a</sup>	SE	QALE at age 18 <sup>a</sup>	SE	QALE loss at age 18 <sup>b</sup>	SE
All	56.8	0.08	28.0	0.19	28.9	0.21
At ages						
At 18	56.8	0.08	28.0	0.2	28.9	0.21
At 25	50.5	0.08	22.7	0.2	27.8	0.20
At 35	41.5	0.08	16.1	0.2	25.4	0.19
At 45	32.8	0.08	10.4	0.2	22.3	0.17
At 55	24.7	0.08	6.6	0.1	18.1	0.17
At 65	17.3	0.08	3.5	0.1	13.8	0.17
At 75	11.2	0.10	1.8	0.1	9.4	0.16
At 85	6.9	0.14	0.9	0.1	6.0	0.15
By sex						
Men	55.2	0.10	25.6	0.33	29.6	0.35
Women	58.4	0.14	29.8	0.24	28.6	0.28
By race/ethnicity						
White non-Hispanics	56.9	0.07	27.6	0.23	29.3	0.24
Black non-Hispanics	53.7	0.27	26.9	0.37	26.8	0.46
Hispanics	58.0	1.58	31.6	0.87	26.4	1.76
By sex and race/ethnicity						
White non-Hispanic men	55.4	0.09	25.6	0.37	29.7	0.38
White non-Hispanic women	58.4	0.10	29.2	0.28	29.2	0.30
Black non-Hispanic men	51.0	0.35	24.9	0.66	26.0	0.72
Black non-Hispanic women	56.2	0.41	28.6	0.45	27.6	0.63
Hispanic men	59.1	0.84	28.2	1.25	30.8	1.48
Hispanic women	57.9	2.36	34.2	1.13	23.7	2.58

SE Standard error of estimate

<sup>a</sup>QALE at age 18 years. For the eight ages, QALE at age 18, 25, 35, 45, 55, 65, 75, and 85 years, respectively<sup>b</sup>QALE loss due to depression at age 18 years. For the eight ages, QALE loss at age 18, 25, 35, 45, 55, 65, 75, and 85 years, respectively

Additional quality-adjusted life expectancy (QALE) loss associated with the increased risk of suicide attributable to depression

Table 4

Sex	Depression	Use all-cause mortality		Use non-suicide mortality		Loss to suicide	
		QALE <sup>a</sup>	SE	QALE <sup>a</sup>	SE	Loss <sup>b</sup>	SE
Both	Yes	27.97	0.19	28.38	0.20	0.41	0.01
	No	56.84	0.08	56.99	0.08	0.15	0.01
Men				Additional loss <sup>c</sup>		0.26	0.01
	Yes	25.64	0.33	26.40	0.35	0.76	0.03
	No	55.24	0.10	55.45	0.10	0.21	0.01
				Additional loss <sup>c</sup>		0.55	0.03
Women	Yes	29.80	0.24	30.02	0.24	0.22	0.02
	No	58.38	0.14	58.46	0.14	0.08	0.02
				Additional loss <sup>c</sup>		0.14	0.02

SE standard error of estimate  
<sup>a</sup> Calculated QALE at age  
<sup>b</sup> QALE loss at age 18 due to additional deaths by suicide  
<sup>c</sup> Additional QALE loss at age 18 due to increased risk of suicide among those with depression

# Describing the population health burden of depression: health-adjusted life expectancy by depression status in Canada

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## Abstract

**Introduction:** Few studies have evaluated the impact of depression in terms of losses to both premature mortality and health-related quality of life (HRQOL) on the overall population. Health-adjusted life expectancy (HALE) is a summary measure of population health that combines both morbidity and mortality into a single summary statistic that describes the current health status of a population.

**Methods:** We estimated HALE for the Canadian adult population according to depression status. National Population Health Survey (NPHS) participants 20 years and older ( $n = 12\,373$ ) were followed for mortality outcomes from 1994 to 2009, based on depression status. Depression was defined as having likely experienced a major depressive episode in the previous year as measured by the Composite International Diagnostic Interview Short Form. Life expectancy was estimated by building period abridged life tables by sex and depression status using the relative risks of mortality from the NPHS and mortality data from the Canadian Chronic Disease Surveillance System (2007–2009). The Canadian Community Health Survey (2009/10) provided estimates of depression prevalence and Health Utilities Index as a measure of HRQOL. Using the combined mortality, depression prevalence and HRQOL estimates, HALE was estimated for the adult population according to depression status and by sex.

**Results:** For the population of women with a recent major depressive episode, HALE at 20 years of age was 42.0 years (95% CI: 40.2–43.8) compared to 57.0 years (95% CI: 56.8–57.2) for women without a recent major depressive episode. For the population of Canadian men, HALE at 20 was 39.0 years (95% CI: 36.5–41.5) for those with a recent major depressive episode compared to 53.8 years (95% CI: 53.6–54.0) for those without. For the 15.0-year difference in HALE between women with and without depression, 12.3 years can be attributed to the HRQOL gap and the remaining 2.7 years to the mortality gap. The 14.8 fewer years of HALE observed for men with depression equated to a 13.0-year HRQOL gap and a 1.8-year mortality gap.

**Conclusion:** The population of adult men and women with depression in Canada had substantially lower healthy life expectancy than those without depression. Much of this gap is explained by lower levels of HRQOL, but premature mortality also plays a role.

**Keywords:** *life expectancy, healthy life expectancy, mortality, health-related quality of life, depression*

## Introduction

Depression contributes significantly to the burden of disease throughout the world,

including in Canada.<sup>1</sup> It is estimated that over 298 million people worldwide are living with depression.<sup>2</sup> In 2012, about 3.2 million Canadians over the age of 15

(11.3%) reported having experienced symptoms consistent with a major depressive episode in their lifetime, while the prevalence of such an episode in the previous 12 months was 4.7% in this population.<sup>3</sup> Women and young people aged 15 to 24 years experienced the highest prevalence of a 12-month major depressive episode.<sup>3</sup>

Depression has an important impact on health-related quality of life (HRQOL), functioning, mortality due to intentional injury and health care utilization.<sup>4,5</sup> In

## Highlights

- Men and women in Canada who have depression live a substantially higher proportion of their life in an unhealthy state compared to their counterparts without depression.
- This gap in healthy life expectancy between Canadians with and without depression is primarily associated with losses in quality of life.
- Emotional state, cognitive state and pain are the key attributes associated with losses in quality of life for Canadians experiencing a recent major depressive episode.
- Based on observations from past studies of the Canadian household population, the burden of depression on healthy life expectancy at a population level appears to be greater than that associated with other chronic conditions such as diabetes, hypertension and obesity.

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addition to these direct negative outcomes, depression has also been demonstrated to increase risk for coronary heart disease,<sup>7</sup> stroke<sup>8</sup> and cancer<sup>9</sup> and a decline in physical functioning.<sup>10</sup> Potential mechanisms for the relationship between depression and physical disease include immune and endocrine dysregulation and inflammatory processes.<sup>11</sup> Depression has also been associated with an increased risk of mortality in general community populations, as well as in patient populations with chronic illnesses such as coronary heart disease, cancer, diabetes and stroke.<sup>11</sup> There are likely reciprocal effects between depression and disease, with depression being a risk factor for, and a sequela of, disease.<sup>11</sup>

Summary measures of population health using the Global Burden of Disease methodology<sup>1,12-15</sup> have ranked depression very high on the list of health conditions contributing to the global and national burden of disease, particularly in terms of losses due to disability. Major depressive episode is the second leading cause of years lived with disability globally<sup>1</sup> as well as in the United States,<sup>12</sup> the United Kingdom,<sup>13</sup> China<sup>14</sup> and Canada.<sup>15</sup>

Less well documented is the association of depression with life expectancy and healthy (or disease-free) life expectancy. Understanding both life expectancy and healthy life expectancy among people who have depression will help to better characterize its disease burden. A recent systematic review and meta-analysis<sup>16</sup> concluded that people living with a mood disorder have a mortality rate twice as high as those without a mood disorder, and potential years of life lost due to mental disorders ranged from 1.4 to 32 years, with a median of 10.1 years. Jia et al.<sup>17</sup> reported that adults living with depression in the United States experienced a 28.9 year loss of quality adjusted life expectancy (QALE) at age 18 compared to those without depression. Results from the few existing studies on healthy or disease-free life expectancy and depression are not consistent.<sup>18-20</sup> A number of these studies are restricted to older adults and thus cannot be generalized to the entire population. These studies also use a measure of functional health restricted to activities of daily living, which do not consider attributes such as pain, emotion and cognition.

The objective of our study was to estimate period life expectancy (LE) and health-adjusted life expectancy (HALE) of Canadian adults (aged 20 years and older) according to depression status. Note that the period approach to estimating LE and HALE adopted in this paper is a summary measure of population health for a given period. Period life expectancy estimates the hypothetical life expectancy of an individual were they to experience the age- and sex-specific mortality rates in a given period. This should not be confused with projected life expectancy based on modeling or cohort life expectancy based on the actual mortality experience of a specific cohort. In a similar fashion, period HALE is a hypothetical estimate reflecting an individual's healthy life expectancy were they to experience the age- and sex-specific mortality and age- and sex-specific HRQOL levels at a given point in time.

These estimates are useful to better understand the population health impact of a condition. They are also useful for informing policy and programs, and for making decisions about the relative burden of specific health conditions. Because of the varied course of depression, with both chronic and episodic cases included in the population studied, the estimates in this study should not be applied to predict the expected health course of any individual.

## Methods

### Data sources

To estimate HALE, several types of data are necessary: all-cause mortality rates by depression status, depression prevalence and HRQOL estimates by depression status. All-cause mortality rates for the Canadian adult population with and without depression were estimated based on a methodology that partitions rates for total population into mortality rates by disease categories using a mortality relative risk or hazard ratios and a prevalence of those categories. The methodology is described in detail in our previous study.<sup>21</sup>

We used data from the following three sources:

- National Population Health Survey (NPHS), for estimating mortality hazard ratios (HRs) by depression status;

- Canadian Community Health Survey (CCHS), for estimating depression prevalence and HRQOL by depression status; and
- Canadian Chronic Disease Surveillance System (CCDSS), for actual age- and sex-specific all-cause mortality rates in the Canadian population, which were then partitioned into those associated with depression and those not associated with depression, based on the mortality HR estimated using the NPHS and depression prevalence estimated from CCHS.

The NPHS is a longitudinal survey conducted by Statistics Canada of 17 276 Canadians of all ages living in households in the 10 provinces. The NPHS has a biennial follow-up spanning the years 1994/95 to 2010/11 and includes death clearance against the Canadian Mortality Database.<sup>22</sup> These data were used to estimate mortality HR associated with depression required for estimating all-cause mortality rates for people with and without depression. Our study population at baseline included 12 373 participants aged 20 years and older.

The CCHS is an annual cross-sectional survey, conducted by Statistics Canada, of a sample of approximately 65 000 Canadians aged 12 years and older living in households in the provinces and territories.<sup>23</sup> Our study used a two-year CCHS sample (2009–2010) and included 103 815 participants aged 20 years and older. We used these data to estimate the prevalence of depression, as well as to attribute depression status in estimating all-cause mortality rates (see “Analysis” section for more detail). We also obtained Health Utilities Index (HUI) scores by depression status from the CCHS. We estimated depression prevalence and HUI scores from the CCHS because the data were more recent, and the larger sample size allowed for more accurate estimation of depression and HUI scores.

We used CCDSS all-cause mortality data for the period of 2007–2009 in the study. The CCDSS collects administrative data that include death and population counts by sex and five-year age groups for all residents of all ages in all provinces and territories, who use the public health care systems. Both mortality and population size information come from provincial and territorial health insurance databases

that cover about 97% of the Canadian population. Data are collected from all Canadian provinces and territories and summarized by the Public Health Agency of Canada.<sup>24</sup>

### Measures

Depression is measured in the CCHS and NPHS using the Composite International Diagnostic Interview Short Form (CIDI-SF) instrument. The CIDI is a structured diagnostic interview, based on diagnostic criteria from the *International Classification of Diseases (ICD-10)* and the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*, that is administered by trained interviewers. The short form of the Interview is based on a subset of CIDI questions that could still reliably reproduce prevalence estimates.<sup>25</sup> The CIDI-SF interview produces scores that give predicted probabilities of depression. For this study, respondents with a predicted probability of 0.9 and above were considered to have experienced a major depressive episode during the previous year. The CIDI-SF was optional content on the 2009–2010 CCHS, and not all provinces and territories chose to include this module. Estimates of depression are based on partial provincial and territorial coverage that includes five provinces (Prince Edward Island, Quebec, Saskatchewan, Alberta and British Columbia) and two territories (Nunavut and Northwest Territories).

HRQOL is measured using the Health Utilities Index Mark 3 instrument in the CCHS. The HUI is a preference-based measure of HRQOL based on responses to questions about functioning for the following eight attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition and pain.<sup>26</sup> Single-attribute utility scores range from 0.0 (lowest level of functioning) to 1.0 (full functional capacity). The eight attributes are combined into an overall score that ranges from 1.00 (perfect health) through 0.00 (death) to –0.36 (the worst possible health state; from a preference perspective, some health states are considered worse than death and are consequently assigned negative scores). A change of 0.03 or more in overall HUI scores and 0.05 or more in single-attribute utility scores is considered clinically important.<sup>27</sup>

The HUI has been widely used, and its validity and reliability in a variety of

applications is supported.<sup>27,28</sup> A study assessing the sensitivity to depression outcomes of several multiattribute utility indexes found HUI to be able to discriminate well between levels of severity in the two depression instruments being evaluated.<sup>29</sup> The HUI score is used as a morbidity measure in the estimation of HALE. Depression typically has a negative impact on the emotional state, including sustained negative affect and difficulties experiencing positive affect.<sup>30</sup> In order to assess whether HRQOL differences are due exclusively to changes in the HUI emotion attribute, we compared HUI scores (all ages combined) by depression status for each of the eight attributes.

### Analysis

Relative risks of mortality by depression status for women and for men were approximated by HRs. The HRs were estimated by fitting sex-specific discrete-time proportional models with a complementary log-log function using the completed NPHS data. We defined people with depression as those with a high probability (0.9) of having had a major depressive episode in the 12 months prior to data collection in at least one NPHS cycle, according to a method described by Simpson et al.<sup>31</sup> The first episode defined a case date. Respondents were followed up for mortality events every two years and a variable for each cycle was included in the model (cycle 1–cycle 9) as a time-interval measure. The sex-specific models were adjusted by age. As the HRs were used to estimate only all-cause mortality rates associated with depression, we did not adjust the models for any other comorbidities, socioeconomic status or other determinants of health. Because of the complex sample design of this survey, we used the bootstrapping method to calculate variance and produce 95% confidence intervals (CIs) for HR.<sup>22</sup> Age- and sex-specific depression prevalences, required for decomposing total mortality rates by depression status, were estimated using the CCHS 2009–2010. Mean HUI estimates by age, sex and depression status were also calculated. Bootstrapping was used to generate 95% CI.<sup>23</sup> In our study, total mortality rates by sex and 5-year age groups were estimated from CCDSS data for the period of 2007–2009. In this study, age- and sex-specific mortality rates for people with depression and for those without depression were estimated by decomposing mortality rates for the total population

following the methodology we described in our previous study.<sup>21</sup>

We used the Chiang method<sup>32</sup> to generate period (2007–2009) sex-specific abridged life tables by depression using 14 standard age groups (20–24, 25–29, ..., 80–84, ≥ 85 years). The Gompertz function was used to provide an accurate estimate of LE for the last open-ended 85-years-plus age interval in order to close the life table, as described by Hsieh.<sup>33</sup> The modified Sullivan method<sup>34</sup> was used for HALE estimation. According to this method the “life-years lived” was adjusted by the HUI.

$$L'_x = L_x * HUI_x$$

where  $L'_x$  is adjusted life-years lived in age-interval  $x$ ,  $L_x$  is life-years lived in age-interval  $x$  and  $HUI_x$  is Health Utilities Index Mark 3 for people in age-interval  $x$ .

The variance of LE and HALE was estimated using bootstrap methodology. Statistics Canada's surveys provide 500 bootstrap weights for variance estimation to account for complex survey designs.<sup>22,23</sup> Using those weights, 500 sets of HR estimates from NPHS and 500 sets of prevalence of depression and HUI estimates from CCHS were generated and all unique combinations of those estimates used to obtain mortality rates to build 250 000 life tables by depression and sex. This allowed estimating LE and HALE variance, building CIs around point estimates and conducting z tests to determine the statistical significance of the differences in LE and HALE. The 95% CIs were built based on the normality assumption. Due to the nature of the study population (adults 20 years and older), LE and HALE results were estimated at age 20 years and not birth.

The Arriaga decomposition, or partitioning, method<sup>35</sup> (adapted for the Sullivan method<sup>34</sup>) was applied to quantify which part of HALE differences according to depression status can be attributable to differences in premature mortality and which are attributable to loss of HRQOL (morbidity). For each age group, the change in HALE between the comparison groups is partitioned into the following components:

$$\Delta HALE = \Delta MORB + \Delta MORT = \frac{L_1 + L_2}{2} \Delta HUI + \frac{HUI_1 + HUI_2}{2} \Delta L_x$$

where  $\Delta MORB$  estimates change due to HRQOL,  $\Delta MORT$  estimates change due to mortality,  $L_{x1}$  and  $HUI_{x1}$  refer to the number of years lived and HUI score respectively for those with depression for age-interval  $x_1$  and  $L_{x2}$  and  $HUI_{x2}$  refer to the number of years lived and HUI score respectively for those without depression for age-interval  $x_2$ . (More details about how this methodology is applied to healthy life expectancy estimations can be found elsewhere.<sup>21,36</sup>)

## Results

Table 1 shows the demographic characteristics of the participants in the NPHS and CCHS, the two national health surveys that we used for this study. The prevalence of major depressive episode in our study population (2009/10) was 5.5% (6.7% for women and 4.2% for men; results not shown).

Based on analysis of the NPHS data, there were 2154 deaths over the 16-year follow-up period. Mortality risk was significantly higher for those who experienced a major depressive episode (age-adjusted HR = 1.43; 95% CI: 1.22–1.68). This significant risk persisted when we restricted analyses to women only (age-adjusted HR = 1.55; 95% CI: 1.28–1.87), while the risk for men was nonsignificant (age-adjusted HR = 1.28; 95% CI: 0.98–1.68) (data not shown).

Unadjusted HRQOL values (as measured by HUI scores) varied by age, sex and depression status (see Table 2). HUI scores were considerably lower in all age groups for men and women who had experienced a major depressive episode during the preceding 12 months compared to those who had not experienced such an episode. According to definitions of disability categories based on global HUI scores developed by Feng et al.,<sup>37</sup> men and women

with depression experienced on average moderate disability (HUI < 0.89) at all age groups, whereas only older ( $\geq 55$  years) men and women without depression fell into this category. Similarly, men with depression on average experienced severe disability (HUI < 0.70) at age 40 years while women experienced this at age 45 years; average HUI scores for men and women without depression did not drop below this threshold at any age group in our study.

An assessment of each of the eight HUI attributes by sex (all ages combined) showed that depression was associated with a clinically meaningful lower score (i.e. a difference of 0.05 or higher) for the emotion, pain and cognition attributes (Table 2).

Both LE and HALE for women with depression were lower than for those without depression; LE for men with depression was not significantly lower whereas HALE was (Table 3). LE at age 20 was 4.1 years (95% CI: 1.1–7.1) lower for women with depression compared to those without, whereas HALE at age 20 was 15.0 years (95% CI: 13.2–16.8) lower for women with depression. For men, the gap in LE at age 20 between those with and without depression was 2.7 years (95% CI: 0.0–5.4), whereas HALE at age 20 for men with depression was 14.8 years (95% CI: 12.3–17.4) lower. LE and HALE at age 65 were lower for both women and men with depression. Women with depression had an LE at age 65 years that was 3.2 years (95% CI: 1.8–4.6) lower and a HALE at age 65 that was 6.7 years (95% CI: 5.3–8.1) lower than women without depression. LE at age 65 years for men with depression was 2.1 years (95% CI: 0.1–4.1) lower than that of men without depression. HALE at age 65 years was 6.0 years (95% CI: 3.8–8.2) less for men with depression compared to those without depression.

An assessment of the individual contribution of loss of HRQOL and premature mortality to differences in HALE at age 20 indicated that, for the 15.0-year difference in HALE between women with and without depression, 12.3 years could be attributed to HRQOL losses and the remaining 2.7 years to mortality losses. The 14.8 fewer years of HALE for men with depression equated to a 13.0-year HRQOL gap

**TABLE 1**  
**Demographic characteristics of survey participants, NPHS 1994/95 and CCHS 2009/10**

Characteristics	NPHS 1994/95	CCHS 2009/10
<b>Age, mean (range) in years</b>	45 (20–100)	47.5 (20–102)
<b>Sex,<sup>a</sup> % (95% CI)</b>		
Male	48.6 (48.3–48.9)	49.1 (49.1–49.1)
Female	51.4 (51.1–51.7)	50.9 (50.9–50.9)
<b>Marital status,<sup>b</sup> % (95% CI)</b>		
Married/common-law	68.3 (67.3–69.3)	65.7 (65.1–66.3)
Single/widowed/divorced/separated	31.7 (30.7–32.7)	34.3 (33.7–34.9)
<b>Highest level of education,<sup>c</sup> % (95% CI)</b>		
Less than high school	25.7 (24.5–26.8)	14.4 (14.1–14.8)
High school graduation	40.7 (39.5–41.9)	23.7 (23.3–24.2)
Post-secondary graduation	33.6 (32.5–34.8)	61.8 (61.3–62.4)
<b>Depression,<sup>d</sup> % (95% CI)</b>		
Yes	NA	5.5 (5.2–5.9)
No	NA	94.5 (94.1–94.8)
<b>Depression<sup>d</sup> in at least one cycle (1994–2008), % (95% CI)</b>		—
Yes	4.7 (4.4–4.9)	NA
No	95.3 (95.0–95.6)	NA

**Abbreviations:** CCHS, Canadian Community Health Survey; CIDI-SF, Composite International Diagnostic Interview Short Form; NA, not applicable; NPHS, National Population Health Survey.

<sup>a</sup> n = 12 373 (NPHS); n = 103 815 (CCHS).

<sup>b</sup> n = 12 371 (NPHS); n = 103 636 (CCHS).

<sup>c</sup> n = 12 347 (NPHS); n = 101 783 (CCHS).

<sup>d</sup> Based on responses to CIDI-SF, indicative of having experienced a major depressive disorder in the previous year. n = 3501 (NPHS); n = 48 355 (CCHS).

**TABLE 2**  
**Health-related quality of life status by sex, age, HUI attribute and depression status<sup>a</sup>, Canada, 2009/10**

	Average Health Utilities Index score (95% CI)			
	Women without depression	Women with depression	Men without depression	Men with depression
<b>Age group (years)</b>				
20–24	0.93 (0.92–0.94)	0.82 (0.77–0.87)	0.93 (0.92–0.94)	0.74 (0.65–0.83)
25–29	0.94 (0.93–0.95)	0.81 (0.76–0.85)	0.93 (0.92–0.94)	0.81 (0.76–0.87)
30–34	0.93 (0.93–0.94)	0.74 (0.65–0.84)	0.93 (0.92–0.94)	0.78 (0.71–0.85)
35–39	0.93 (0.92–0.94)	0.74 (0.64–0.84)	0.93 (0.92–0.94)	0.80 (0.74–0.87)
40–44	0.91 (0.90–0.92)	0.73 (0.68–0.78)	0.91 (0.89–0.92)	0.68 (0.60–0.77)
45–49	0.91 (0.89–0.92)	0.63 (0.54–0.71)	0.92 (0.90–0.93)	0.67 (0.58–0.76)
50–54	0.90 (0.89–0.91)	0.69 (0.63–0.75)	0.91 (0.90–0.91)	0.66 (0.59–0.73)
55–59	0.88 (0.87–0.89)	0.71 (0.65–0.77)	0.88 (0.87–0.89)	0.59 (0.49–0.70)
60–64	0.88 (0.87–0.89)	0.68 (0.62–0.75)	0.90 (0.89–0.91)	0.62 (0.52–0.72)
65–69	0.87 (0.86–0.88)	0.59 (0.49–0.69)	0.88 (0.87–0.89)	0.60 (0.49–0.71)
70–74	0.86 (0.85–0.88)	0.67 (0.58–0.77)	0.87 (0.85–0.88)	0.63 (0.45–0.81)
75–79	0.81 (0.78–0.83)	0.66 (0.54–0.78)	0.83 (0.81–0.85)	0.69 (0.39–1.00)
80–84	0.79 (0.77–0.82)	0.48 (0.16–0.81)	0.79 (0.76–0.82)	0.36 (–0.01–0.73)
≥ 85	0.72 (0.69–0.75)	0.52 (0.37–0.67)	0.74 (0.70–0.78)	0.44 (0.10–0.79)
<b>HUI attribute</b>				
Vision	0.99 (0.99–0.99)	0.99 (0.98–0.99)	0.99 (0.99–0.99)	0.99 (0.99–0.99)
Speech	1.00 (1.00–1.00)	1.00 (1.00–1.00)	1.00 (1.00–1.00)	1.00 (1.00–1.00)
Pain	0.97 (0.97–0.97)	0.92 <sup>b</sup> (0.91–0.93)	0.98 (0.97–0.98)	0.93 <sup>b</sup> (0.91–0.94)
Mobility	0.99 (0.99–0.99)	0.99 (0.98–0.99)	1.00 (1.00–1.00)	0.99 (0.98–0.99)
Hearing	1.00 (1.00–1.00)	1.00 (1.00–1.00)	1.00 (1.00–1.00)	0.99 (0.99–1.00)
Emotion	0.99 (0.99–0.99)	0.94 <sup>b</sup> (0.93–0.95)	0.99 (0.99–0.99)	0.92 <sup>b</sup> (0.91–0.93)
Dexterity	1.00 (1.00–1.00)	1.00 (1.00–1.00)	1.00 (1.00–1.00)	1.00 (1.00–1.00)
Cognition	0.98 (0.98–0.98)	0.93 <sup>b</sup> (0.92–0.94)	0.98 (0.98–0.98)	0.93 <sup>b</sup> (0.92–0.94)

**Abbreviations:** CI, confidence interval; CIDI-SF, Composite International Diagnostic Interview Short Form; HUI, Health Utilities Index.

**Note:** Light shading signifies moderate disability (global HUI score of 0.70–0.88); dark shading signifies severe disability (global HUI score < 0.70); no shading represents either no disability (global HUI score = 1.00) or mild disability (global HUI score = 0.89–0.99).

<sup>a</sup> Based on responses to CIDI-SF, indicative of having experienced a major depressive episode in the previous year.

<sup>b</sup> Clinically meaningful difference in attribute-specific HUI score between those with and without depression.

and a 1.8-year mortality gap (data not shown).

We found large differences between adult Canadians with and without depression in terms of the percentage of their life spent in an unhealthy state (calculated as [LE – HALE]/LE; see Figure 1). Both men and women with depression spent almost three times as much of their life expectancy at age 20 in poor health when compared to those without depression (31% vs. 12% for females and 32% vs. 11% for males). These large differences persisted across age groups: based on LE and HALE at age 65, men and women with depression were still living approximately twice

as long in poor health as men and women of the same age without depression (40% vs. 19% for women and 43% vs. 17% for men).

## Discussion

In this study, we found significantly lower LE at age 20 for women, and HALE at age 20 for both women and men, among Canadians reporting symptoms consistent with a major depressive episode in the previous 12 months. We found this across age groups, although gaps in the proportion of life expectancy spent in an unhealthy state were greater among men and younger age groups with depression.

Although direct comparisons with other health problems need to be interpreted with caution, we found that losses of HALE associated with depression in the Canadian adult population were larger than those observed for obesity class 2 and above,<sup>21</sup> and for diabetes and hypertension<sup>38</sup> in the same population. In addition, while those studies found a greater loss of HALE among women than men, we demonstrated approximately equal losses for both sexes.

Our results align with those of Jia et al.,<sup>17</sup> who reported a 28.9-year QALE loss at age 18 for adults with depression, which is substantively larger than the approximately



**TABLE 3**  
Life expectancy and HALE at age 20–24 and at 65–69, by sex and depression status<sup>a</sup>, Canada, 2009/10

	Age group, years	Years (95% CI)			
		Women without depression	Women with depression	Men without depression	Men with depression
Life expectancy	20–24	64.9 (64.8–65.0)	60.8 (59.0–62.6)	60.4 (60.3–60.5)	57.7 (55.0–60.4)
	65–69	22.4 (22.3–22.5)	19.2 (17.8–20.6)	19.1 (19.1–19.1)	17.0 (15.0–19.0)
Health-adjusted life expectancy	20–24	57.0 (56.8–57.2)	42.0 (40.2–43.8)	53.8 (53.6–54.0)	39.0 (36.5–41.5)
	65–69	18.1 (17.9–18.3)	11.4 (10.0–12.8)	15.8 (15.6–16.0)	9.8 (7.6–12.0)

**Abbreviations:** CI, confidence interval; CIDI-SF, Composite International Diagnostic Interview Short Form; HALE, health-adjusted life expectancy.

<sup>a</sup> Based on responses to CIDI-SF, indicative of having experienced a major depressive episode in the previous year.

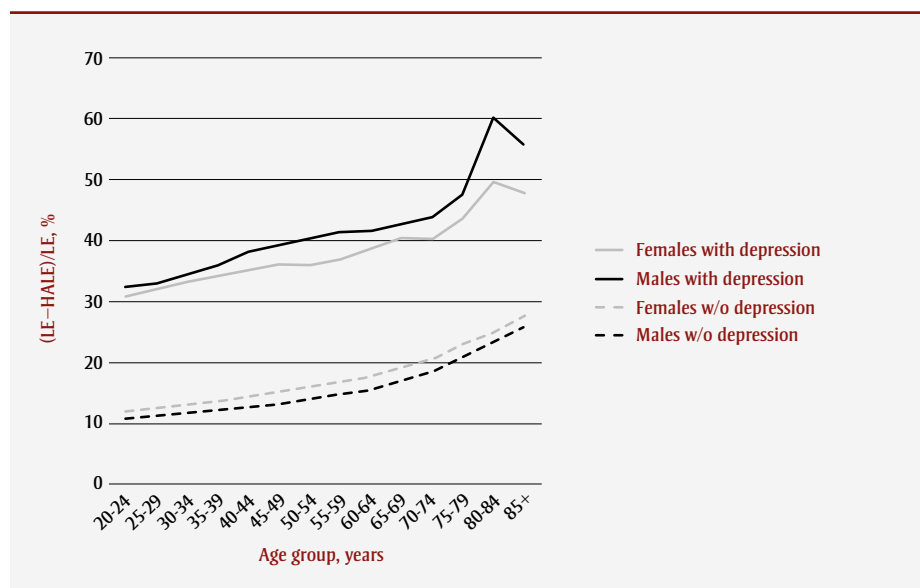
15-year loss of HALE at age 20 for adults with depression that we report. This may be explained both by real differences in the health experience of the Canadian and US populations and by methodological differences between our studies. Moreover, the hazard ratio for mortality associated with depression we observed (HR = 1.43) is somewhat smaller than the relative risk of mortality of 2.08 for adults

with depression reported in the meta-analysis by Walker et al.<sup>16</sup> Studies of older adult populations report a lower life expectancy for participants with depression. Both Chiao et al.<sup>18</sup> and Pérès et al.<sup>20</sup> report life expectancy at 65 years old as lower by approximately one year for participants with depression, whereas Reynolds et al.<sup>19</sup> found that life expectancy at age 70 of individuals with depression in the absence of other

chronic diseases was reduced by approximately three years. While these studies found decreases in health expectancy in their participants living with depression, the magnitude of these decreases is less than we found in our study, except for male participants in the Reynolds et al.<sup>19</sup> study. The larger differences may be due to the fact that our measure of HRQOL included attributes not found in the Activities-of-Daily-Living measure of disability used in those three studies.

We found that a large portion of the lower HALE in participants with depression was due to lower levels in HRQOL. A comparison of each HUI attribute (Table 2) demonstrated that, although there is a clinically meaningful difference between men and women with and without depression for the emotion attribute, there are also meaningful differences for the pain and cognition attributes. Although the association between pain and depression is well documented, the relationship is complex and causal pathways are not thoroughly understood: data support both a model where depression leads to changes in the individual that increase their vulnerability to pain, as well as scenarios where pain symptoms are a risk factor for future depression.<sup>39</sup> Cognitive dysfunction has also been found in a large proportion of patients with depression and has been demonstrated to exist early on in the course of depression; it may even precede diagnosis.<sup>40</sup>

**FIGURE 1**  
Percentage of life spent in an unhealthy state<sup>a</sup>, by sex, age and depression status<sup>b</sup>, Canada, 2009/10



**Abbreviations:** CIDI-SF, Composite International Diagnostic Interview Short Form; HALE, health-adjusted life expectancy; LE, life expectancy; w/o, without.

<sup>a</sup> (LE-HALE)/LE.

<sup>b</sup> Based on responses to CIDI-SF, indicative of having experienced a major depressive episode in the previous year.

In addition to the expected lower values of HALE associated with lower HRQOL, we also found that a considerable amount of the decrease could be attributed to premature mortality. While our results found women demonstrated the largest losses of life expectancy, other studies on mortality risk and life expectancy according to depression status found that men had the greater mortality risk or loss of life expectancy.<sup>11,17,19,20</sup> However, most of these studies tended to focus on elderly or older adult populations that likely have a different risk profile than the full adult population. Indeed, Shah et al.<sup>41</sup> assessed both sex and age differences in the association of depression with mortality and found significant depression-age-sex interactions: mortality risk increased for men as age increased above 55 years while the inverse was found for women. Further study should be undertaken in non-elderly populations in order to better understand this phenomenon.

## Strengths and limitations

Our study benefitted from comprehensive data used to estimate LE and HALE across the age spectrum of adults in Canada. The survey data we used are from large, population-based samples of the Canadian household population: the NPHS allowed us to follow the mortality experience of over 12 000 adult Canadians for 16 years, a longer period than any of the other studies evaluating the association of depression status with life expectancy and/or healthy life expectancy.

Our study has several limitations. When estimating mortality risk, we only considered the first observed episode of probable depression based on the CIDI-SF and did not include depression status at subsequent follow-up. This could have led to misclassification of subjects whose depression status changed.

The definition of depression used in this study (predicted probability of major depressive episode of 0.9) is consistent with the recommended use of the CIDI-SF instrument and corresponds to reporting five to nine symptoms consistent with depression, including one of two cardinal symptoms. This measure was developed for the National Comorbidity Survey in the United States. A 0.9 predicted probability is a high threshold that likely results in more false negatives than false positives, and thus will underestimate, rather than overestimate the burden of depression in Canada.<sup>42</sup>

The CIDI-SF is an optional item in the CCHS and, as such, does not include responses from all Canadian provinces and territories, which may limit the representativeness of our results. We assessed the impact of the missing jurisdictions using an earlier CCHS cycle (2000/01) that included major depressive episode results for all provinces and territories. Age- and sex-specific major depressive episode prevalences from this cycle did not change appreciably when we removed the jurisdictions missing from the 2009/10 cycle, suggesting that representativeness of our study population was not affected by the missing jurisdictions. It should also be pointed out that our measure of depression, recent major depressive episode, does not adequately capture losses in healthy life expectancy specific to longer-term, chronic depression.

The CCHS is a household survey, and by excluding other populations, such as those living in institutions and long-term care facilities, it is possible that the prevalence of depression does not reflect that of the entire Canadian population. There may be differential non-response on the NPHS and CCHS: people with depression may be less likely to respond, resulting in an underestimation of the prevalence of depression. However, this would mean that our estimates are conservative, and that the true burden of depression may be higher than we report.

Our study aimed to describe the association between depression and healthy life expectancy and did not seek to understand the modifying influence of socioeconomic status or of other health conditions. However, in describing the mortality and morbidity of people with depression, it would be inappropriate to adjust for comorbid conditions. The influence on healthy life expectancy of health conditions that are comorbid with depression is unclear. While Pérès et al.<sup>20</sup> only found significant differences in healthy life expectancy between those with and without depression among those reporting three or more chronic conditions, Reynolds et al.<sup>19</sup> found large, significant differences in healthy life expectancy when comparing those with depression to those without in the absence of chronic diseases. Further study is needed to determine the impact of these risk factors and other potentially positive modifying effects, such as social participation, on healthy life expectancy.<sup>18</sup>

Finally, the approach to summarizing population health in this study represents the life and healthy life expectancy experience by a population at a given point in time, based on age- and sex-specific mortality and HRQOL estimates. These period estimates of life expectancy and HALE should only be interpreted as summary measures of population health, and not as the life and healthy life expectancies of any real individual.

## Conclusion

This study demonstrates that, at the Canadian population level, women who have recently experienced a major depressive episode have a significantly lower period life expectancy and HALE at age 20 years than those who have not; for men, period HALE at age 20 is significantly

lower for those who recently experienced a major depressive episode. Losses in HALE due to lower HRQOL are considerable and, while not as large, losses due to increased mortality risk also contribute to this difference, particularly among women. These findings demonstrate a high burden of depression in the Canadian population.

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Colin Steensma contributed to the study design, developed the first draft of the article, and critically reviewed the article. Lidia Loukine contributed to the study design, conducted all statistical analyses, wrote parts of the article, and critically reviewed the article. Heather Orpana contributed to the study design, wrote parts of the article, and critically reviewed the article. Louise McRae contributed to the study design and critically reviewed the article. Julie Vachon contributed to the study analysis and data interpretation and critically reviewed the article. Frank Mo, Michèle Boileau-Falardeau and Carrie Reid contributed to the data interpretation and critically reviewed the article. Bernard Choi contributed to the study concept and critically reviewed the article.

Data used in this study were accessed through sharing agreements with Statistics Canada and the Canadian provinces and territories. Other researchers can access Statistics Canada data through the Data Liberation Initiative of Statistics Canada.

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